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Analysis and Prospects

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Evaluating Global Macroeconomic Models

A Case Study of MULTIMOD

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Structural and theoretical properties of macro models direct their responses. The simulation results of MULTIMOD uphold the Mundell-Flemming story. The model's forward looking property allows faster adjustment of all prices including exchange rates. Its responses are symmetric, but the degree of linearity varies with the magnitude of policy shocks.

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The growing role of multiregional macro models in the discussion of international macroeconomic policy issues necessitates study of their structural and theoretical properties before using them — as is planned, for example, in the International Economics Analysis and Prospects Division. Two questions arise. First, of the model's exogenous variables and coefficients, which ones have more influence on the endogenous variables of interest? Second, what tools and techniques are available to examine the functioning of the models with respect to their structural properties?

Jamshidi explored the above objectives in the IMF's MULTIMOD by evaluating its theoretical specifications and validating its structural properties.

He found the model relatively small and simple in its theoretical specification, but advanced in its modeling techniques, exemplified by its "forward-looking" features. The estimation scheme employed emphasizes the comparability across countries through standardization of specifications and imposition of common coefficients. Thus, the differences in countries' responses to policy shocks are attributable to the differences in their structural features.

The model's forward-looking property allows faster adjustment of all prices, including exchange rates and interest rates, than do conventional macro models. A major strength of the model is the effective transmission of policy changes across countries.

The examination of linearity and symmetry measures, using Zellner-Peck techniques, suggests that the responses of the model are highly symmetric and increasingly nonlinear with the growing magnitude of shocks. (In nonlinear models multipliers depend on the starting values of the endogenous variables, and simulation results are very sensitive to exogenous variables time paths.)

MULTIMOD can be used in many ways to discuss North-South issues. The expansion of North-South links, especially financial links, would widen the scope for generating useful scenarios.

Simulation examples are presented for monetary and fiscal policy scenarios in the North (with their impacts on the developing economics), oil price shocks, and debt relief schemes.

This paper is a product of the Analysis and Prospects Division, International Economics Department. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Mila Divino, room S7-037, extension 33739 (83 pages with figures and tables).

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The simulation experiments are all carried out by the author and he is solely responsible for the results and any errors. The model used in this paper is based on an earlier version (1988) of MULTIMOD.

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I. Introduction

The international debt crisis of the developing countries and its ramification for their creditors, combined with greater need for the coordination of monetary and fiscal policies among OECD members, have highlighted growing world economic interdependence. This situation has given greater prominence to the role of multiregional macroeconometric models in the analysis of this interdependence.

This paper is a contribution to the understanding of global interconnections through the evaluation and validation of the capabilities and properties of MULTIMOD, a multiregional macroeconometric model, developed and maintained at the International Monetary Fund.[1] It represents a self-contained segment of the on-going research in the International Economic Analysis and Prospects Division (IECAP) directed at implementing small-sized regional macroeconometric models into its global analysis. The results of this study are helpful in this endeavor in several ways. First, they improve the understanding of the issues currently discussed in the growing field of multiregional macroeconometric modeling. Second, they buttress the analysis of macroeconomic decision-making in the industrialized countries and its impact on economic activity of developing countries. Finally, the results are complementary to other modeling efforts in IECAP, especially the Capital Flows Model (CFM), due to the closeness of the CFM's specification to that of MULTIMOD.

The contents of the paper are of more general interest as well. Among the special features of MULTIMOD is the explicit treatment of developing countries and high income oil exporters, which is a rarity among multiregional macroeconometric models. The production in the developing countries is disaggregated between manufactures, oil and primary commodities. The region is assumed to be faced with an endogenous supply schedule for foreign loans that depends on a

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[1] The basic reference for MULTIMOD is Paul Masson, Steven Symansky, Richard Haas, and Michael Dooley: "MULTIMOD: A Multi-Region Econometric Model," IMF Working Paper, 88/23, May 1988. This work uses the May 1988 release of the model.

forward-looking assessment of developing countries' debt servicing capacity. The developing countries as a whole are the suppliers of excess demand for oil, the price of which is determined by a weighted average of GNP deflators in the industrialized countries. Further, MULTIMOD implements a forward-looking framework, and, as such, represents the state-of-the art in macroeconometric modeling. An overview of the characteristics and structural properties of the model is given in Section II.

The paper should be of interest also from the standpoint of the methodology for the evaluation and validation of macroeconometric models. In general, diversity of the structural properties leads to variation of responses among different models. By "evaluation" we mean identifying and determining how the presence of each structural property directs the responses of the model. For example, the forward-looking property of MULTIMOD results in a faster adjustment in relative and absolute prices than in many conventional models. The large deviation of prices from those in the control solution are then reflected in short-term interest rates and exchange rates. In MULTIMOD, the focus is primarily on the analysis of comparative scenarios and the transmission of policy effects, and the inherent structural properties of MULTIMOD are designed to support this primary concern. Common coefficients, when they are not significantly different, are frequently imposed across countries, thus minimizing *ad hoc* differences in country responcses. Differences in the economic structure of different countries and regions (for example, degree of openness, trading patterns, and government financial structure), nevertheless, result in differing responses to changes in exogenous variables. These issues are discussed in Section III.

The effective implementation of a macroeconometric model, aside from its theoretical specification, requires the understanding of its statistical properties and model structure. By "validation" we mean a structural sensitivity analysis of the model with a view to identifying the essential behavioural determinants of the model. Section IV spells out this framework.

The conclusions of the study are presented in Section V.

II. A Brief Account of MULTIMOD

A. General Description

MULTIMOD is a multiregional macroeconometric model, which uses annual data. Four features distinguish it from other similar models.[2] First, MULTIMOD employs a rational (as opposed to adaptive) expectations scheme.[3] Second, it explicitly includes developing countries as a region. Third, the model is not designed to produce baseline or unconditional forecasts, but to compare scenarios under alternative policy regimes. With MULTIMOD, one typically starts with country specific forecasts as the baseline which are usually based on detailed knowledge gleaned from individual country desks, and uses the model to examine the effects on that baseline of policy changes in major countries as well as of exogenous changes in the economic environment.[4] It is possible, however, to explore the forecasting capabilities of the model by making some adjustments.[5] The final distinguishing feature of MULTIMOD is the standardized approach it takes in the design of industrial country blocks. A general prototype block of equations is first specified for a typical industrialized country and then applied to all industrialized countries as well as regions. This design

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[2]The better-known multi-country models include: the Federal Reserve's MCM (Edison, *et al*, 1986), the Japanese Economic Planning Agency Global Model (EPA, 1987), the OECD INTERLINK Model (Richardson, 1988), the Project LINK World Model, the McKibbin-Sachs Global (MSG) model (McKibbin and Sachs, 1988), and John Taylor's model (Taylor, 1988). MULTIMOD is smaller in size than the first four of these models, more aggregative in structure than the others, and employs rational expectations, as do the MSG and Taylor models. Further, it has a fuller treatment of developing countries than the other models with the exception of the Project LINK World model.

[3]The expression "consistent expectations" has also been used in the literature for "rational expectations." Masson, *et al*, (1988) further qualifies it as "model-consistent." Another popular expression is "forward-looking." This work uses forward-looking and rational expectations interchangeably.

[4]The paper takes the liberty of quoting freely from the original document on MULTIMOD.

[5]The presence of serial correlation is a serious problem in this effort.

permits the pooling of time-series and cross-sectional data for efficient estimation of common coefficients in many instances[6].

The country coverage of MULTIMOD is organized in terms of seven blocks, where a block is a set of equations pertaining to an country or a region. The industrialized countries are grouped into five blocks comprising individual country blocks for the United States (US), Japan (JA), and the Federal Republic of Germany (GR), and two aggregate regional blocks: the "larger industrialized countries (LI)" and the "smaller industrialized countries (SI)." The former consists of the other four G-7 countries (France, the United Kingdom, Italy and Canada),[7] and the latter, eleven smaller OECD countries.[8] The remaining two blocks are the "high-income oil exporters (HO)" and the "developing countries (DC)".[9] For analytical convenience, especially in handling adding-up restrictions, the last two are often conceived of jointly as constituting a "rest of the world (RW)" block.

The model consists of aggregate demand and aggregate supply relationships with endogenous determination of interest rates, prices, and exchange rates in the industrialized countries. The structure of the developing country block is different from the common structure employed for the industrialized countries. The economic performance of developing countries is assumed to be subject to financial constraints, and their financial flows depend on their expected debt service ability. They have limited control on policies that alter their economic outcomes.

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[6]Other models of this kind are OECD INTERLINK, MSG, and John Taylor's model. For more detail see Helliwell, J. F. (1988).

[7]In the latest (April 1989) version of MULTIMOD, the LI block is replaced by individual country blocks for the four constituent countries: Canada, France, Italy, and the U.K.

[8]Australia, Austria, Belgium, Denmark, Finland, Iceland, Ireland, Luxemburg The Netherlands, New Zealand, Norway, Spain, Sweden, and Switzerland.

[9]High Income Oil Exporting Countries include: Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.

Although "DC" is generally used to refer to developed countries, but for the sake of consistency with the original notation on MULTIMOD, "DC" is used in this paper to refer to developing countries.

B. Commodity Disaggregation and Market Mechanism

Trade is disaggregated into three classes of traded goods: non-oil primary commodities, oil and manufactures. Non-oil primary commodities constitute a homogeneous good commanding a single world price. It is produced by developing countries, and imported by the industrialized countries and high income oil exporters.[10] If their joint demand exceeds supply, the primary commodity price adjusts instantaneously, the elasticity of supply being zero in the short run. In the long run, increase in the capital stock brings about supply growth to correct any sustained shortfall.

Oil is also treated as a homogeneous good, but is produced by all the countries and regions. The real price of oil is taken to be exogenous, and the nominal price is determined by inflating the real price using an aggregate price index which is a weighted average of the industrialized countries' GNP deflators. All industrialized country blocks have variables for production, consumption, export and import of oil: production and export are exogenous, consumption is a function of total output and relative prices, and import demand is determined residually. The sum of import demands in the industrialized country blocks together with oil imports by the developing country block makes up the world demand for oil imports. Both high income oil exporters and developing countries respond to changes in the world oil demand by adjusting their production which is distributed between the two blocks according to a fixed proportion. In effect, production and export of oil in the DC and HO blocks are determined endogenously so as to equate world demand and world supply.

Unlike the treatment of primary commodities and oil, manufactured goods are assumed to be non-homogeneous commodities. They are produced by all the countries (or regions) and are distinguished in the model by the country (or region) of origin. The exports and imports of manufactures in all the blocks are determined endogenously (except for the exports of the HO block). This system of endogenous determination of trade flows generally leads to a discrepancy

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[10]The primary commodities produced and exported by industrialized countries -- including agricultural commodities -- are included implicitly in the "manufactures" that is produced by industrialized countries.

between total imports and total exports which the model resolves by distributing it among all the trading partners according to some fixed shares. There are six manufactured goods prices in the model, one each for the five industrialized country blocks and one for the rest of the world block. The prices are not assumed to be perfectly flexible, but to move slowly to clear the market.

C. Linkages

The model has been designed with a view to focussing on the alternative channels through which the effects of policy changes are transmitted. These channels are: trade flows, goods prices, exchange rates, interest rates, and the international flow of funds.

The trade flows interact through the three tradable goods markets. Demand for oil and primary commodities by the industrialized countries constitutes a significant proportion of the production in the DC region and a still larger proportion of production in the HO region. A rise in demand for the output (oil or primary commodities) of the developing countries translates into an increase in the imports of manufactures from the industrialized countries by the developing countries. The interaction in the manufactured goods market is multi-dimensional. A change in demand for imports of manufactures in any block leads to a change in the exports of the other blocks in accordance with a base-year trade share matrix. As a second round effect, in each block, the demand for import of manufactured goods from all the other blocks changes. In the model, trade prices have a direct and widespread feedback effect on one another. First, as mentioned above, the nominal world oil price is determined by the real oil price adjusted by a weighted average of the domestic prices of the industrialized countries. Second, for each block, the manufactures export price is a function *inter alia* of an aggregate index, PFM, of competitors' prices in foreign markets. A change in the price of manufactures exports feeds back into itself through PFM.

Exchange rates and interest rates also transmit the effects of changes from one block to another. The U.S. short-term nominal interest rate has a determining role in the model. First, a change in the US interest rate has a direct effect on the interest payments of the developing

countries on their debt. Second, the model assumes the "uncovered interest parity" which links the interest rate differentials between the United States and any industrialized country to the movements in their exchange rates.

D. Estimation and Solution

Most of the parameters of the model are estimated using historical data. In many instances, a single equation is estimated for all five industrialized country blocks using pooled cross-section method and in some cases common coefficients were imposed across the blocks if the hypothesis of equal coefficients could not be rejected. Such a procedure, which is an attempt to standardize macroeconomic relations, reduces the variation of responses across different blocks but does not eliminate them.

One feature of the model that complicates its solution is the presence of expectation variables in some of the stochastic equations. These variables are: (1) nominal exports of the developing country block (with four period leads), (2) exchange rates, inflation rates and nominal exchange rates of the industrialized country blocks (each with one period lead), and (3) interest rates (with one period lead). The forward-looking property of the model consists in constraining the expectations of these variables to be identical to their respective values in the model solution.

The expectations variables are solved for using the Fair-Taylor algorithm and simulated using the TROLL "Forward-Looking Simulator".[11]

E. Behavioral Equations and Estimated Coefficients

The behavioral equations in MULTIMOD along with their estimated coefficients are shown in Table 1.[12] The model has a total of 308 equations. Table 2 gives their break-down by type (behavioural, empirical and definitional), by sector of the economy, and by country or region.

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[11] See Fair and Taylor (1983), Fair (1984: Chapter 11), and Peter Hollinger (1987).

[12] For the explanation of the choice of variables in each equation see Masson et al (May 1988).

TABLE 1

BEHAVIORAL EQUATIONS AND ESTIMATED COEFFICIENTS IN MULTIMOD

Equations	LHS	Coefficients US	JA	GR	LI	SI	DC	HO	RW	RHS
Consumption										
1	Δlog(C)	.084	.094	.094	.095	.094				$\log(W_{-1}/C_{-1})$
		(2.1)	(2.1)	(2.1)	(2.1)	(2.1)				
		-.415	-.415	-.415	-.415	-.415				ΔRLR
		(1.7)	(1.7)	(1.7)	(1.7)	(1.7)				
		.506	.506	.506	.506	.506	.366			Δlog(YD)
		(5.6)	(5.6)	(5.6)	(5.6)	(5.6)	(2.5)			
							.373			$\log(YD_{-1})$
							(4.2)			
							-.316			$\log(C_{-1})$
							(3.9)			
Oil Consumption Equations										
2	Δlog(COIL)	.723	1.499	1.54	1.749	.868				Δlog(GDP)
		(2.8)	(7.2)	(5.2)	(4.2)	(2.2)				
		-.054	-.026	-.100	-.043	-.085				Δlog(POIL_/PGNP)
		(2.5)	(1.4)	(5.1)	(2.1)	(4.2)				
		-.049	-.049	-.049	-.049	-.049				$\log(POIL_{-1}/PGNP_{-1})$
		(9.3)	(9.3)	(9.3)	(9.3)	(9.3)				
		.075	.075	.075	.075	.075				$\log(GDP_{-1}/COIL_{-1})$
		(2.9)	(2.9)	(2.9)	(2.9)	(2.9)				
Change in Capital Stock Equations (Investment)										
3	Δlog(K)	.156	.156	.156	.156	.156				$\log(GDP_{-1}/K_{-1})$
		(8.5)	(8.5)	(8.5)	(8.5)	(8.5)				
		.086	.086	.086	.086	.086				Δlog(GDP)
		(1.5)	(1.5)	(1.5)	(1.5)	(1.5)				
		-.084	-.084	-.084	-.084	-.084				UCSTCAP
		(1.8)	(1.8)	(1.8)	(1.8)	(1.8)				
		-.011	-.011	-.011	-.011	-.011				DUM74
		(3.2)	(3.2)	(3.2)	(3.2)	(3.2)				
Manufactured Exports										
4	log(XM)	1.	1.	1.	1.	1.		1.		log(FM)
		-.496	-.496	-.496	-.496	-.496		-.496		REER
		(9.3)	(9.3)	(9.3)	(9.3)	(9.3)		(9.3)		
		-.015	.026	-.012	-.011	-.015		.010		T
		(6.8)	(12)	(5.5)	(5.2)	(6.6)		(4.2)		
Imports of Manufactures										
5	log(IM)	1.a/	1.a/	1.a/	.294	1.a/		1.a/		log(A)
		0	-.581 b/	0	0	0				$\log(A_{-1})$
		-.800	-.592	-.740	-.483	-.221				log(PIMA/PGNPNO)
		(6.3)	(3.3)	(5.2)	(2.0)	(1.6)				
		.035	0	.031	0	0				T
		(17.)		(16.)						
		0	.581	0	.705 c/	0				$\log(IM_{-1})$
			(5.1)							
								-1.26		log(PIMA/PGNP)
								(0.4)		
								0.745		$\log(IM_{-1})-\log(A)$
								(3.9)		

The numbers in parenthesis are 't' ratios.
a/ Constrained to a unity.
b/ Constrained to be equal to $-\phi$, where ϕ is coefficient of IM_{-1}.
c/ Constrained to eqal $(1 - \alpha)$, where α is coefficient of A.

Table 1 continued

Equations	LHS	Coefficients US	JA	GR	LI	SI	DC	HO	RW	RHS
Imports of Primary Commodities										
6	Δlog(ICOM)	-.641	-.619	-.518	-.514	-.514				Δlog(PCOM/PGNP*ER)
		(6.4)	(3.7)	(6.2)	(6.2)	(4.1)				
		1.986	0	1.809	2.44	2.09		1.391		Δlog(GDP)
		(1.6)		(3.9)	(3.1)	(2.8)		(1.3)		
		-0.158	-.757	0	-.177	-.262				$\log(PCOM_{-1}/PGNP_{-1}*ER_{-1})$
		(1.6)	(3.2)		(1.6)	(1.3)				
		.754	.156	.453	.149	.565				$\log(GDP_{-1})$
		(4.1)	(0.8)	(3.7)	(2.6)	(2.8)				
		-.786	-.570	-.512	-.602	-.709				$\log(ICOM_{-1})$
		(4.2)	(2.8)	(3.6)	(2.7)	(2.6)				
								-1.034		Δlog(PCOM/PXM*ER)
								(2.6)		
Money Demand Function										
7	log(M/P)	.188	.188	.188	.188	.188				log(GNP)
		(5.7)	(5.7)	(5.7)	(5.7)	(5.7)				
		-.007	-.007	-.007	-.007	-.007				RS
		(4.0)	(4.0)	(4.0)	(4.0)	(4.0)				
		-.0074	-.0074	-.0074	-.0074	-.0074				RS_{-1}
		(4.0)	(4.0)	(4.0)	(4.0)	(4.0)				
		.805	.805	.805	.805	.805				$\log(M_{-1}/P_{-1})$
		(29)	(29)	(29)	(29)	(29)				
Non-Oil GNP Price Deflator										
8	Δlog(PGNPNO)	.168	.168	.168	.168	.168				log(CU)
		(1.5)	(1.5)	(1.5)	(1.5)	(1.5)				
		.5	.5	.5	.5	.5				$\log(CU_{-1})$
		(1-.287)	(1-.515)	(1-.489)	(1-.570)	(1-.580)				$\Delta\log(PGNPNO_{-1})$
		.287	.515	.489	.570	.580				PI(1)
		(1.4)	(5)	(1.9)	(5.3)	(2.2)				
Non-Fuel Export Prices										
9	Δlog(PXM)	.704	.575	.767	.637	.684				Δlog(PGNPNO)
		(7.9)	(6.8)	(6.8)	(5.4)	(3.7)				
		(1-.065)	(1-.065)	(1-.065)	(1-.065)	(1-.065)				Δlog(PFM)
		.065	.065	.065	.065	.065				$\log(PGNPNO_{-1}/PXM_{-1})$
		(1.5)	(1.5)	(1.5)	(1.5)	(1.5)				

*Definition of Variables:

A = Domestic Absorption
C = Consumption Expenditure
COIL = Consumption of Oil
CU = Capacity Utilization
ER = Exchange Rate, $ per Local Currency
FM = Foreign Export Markets for Manufactures
GDP = Gross Domestic Product, in Real Terms
ICOM = Import Volume, Commodities
IM = Import Volume, Manufactures
K = Real Net Capital Stock
M = Monetary Base
P = Absorption Deflator
PCOM = Price of Primary Commodity Exports of LDCs, U.S. Dollar Index
PFM = Prices in Foreign Markets
PGNP = Price Level (GNP Deflator)
PGNPNO = Non-Oil GNP Deflator
PI = Inflation Rate (Change in Absorption Deflator)
PIMA = Manufacture Import Prices - Adjustment for Nominal World Trade Discrepancy
POIL = Price of Oil, in U.S. Dollars (1980=1)
PXM = Manufactures Export Prices
REER = Real Effective Exchange Rate
RLR = Real Ex Ante Long-Term Interest Rate
RS = Short-Term Nominal Interest Rate
T = Time
UCSTCAP = Real User Cost of Capital
W = Real Net Wealth
XM = Export Volume, Manufactures
YD = Real Disposable Income

Table 2

CLASSIFICATION OF EQUATIONS OF MULTIMOD

SECTOR	INDUSTRIALIZED Countries								REST OF THE WORLD																			
	Industrialized Blocks' Prototype (1)				Five Industrial Countries or Regions (2)=(1)*5				Developing Countries (DC) (3)				High Income Oil Producing (HO) (4)				Rest of the World Block (RW) (5)				Total (6)=(3)+(4)+(5)				Model (7)=(2)+(6)			
	B.	E.	D.	T.	B.	E.	D.	T.	B.	E.	D.	T.	B.	E.	D.	T.	B.	E.	D.	T.	B.	E.	D.	T.	B.	E.	D.	T.
1. Aggregate Demand	6	1	11	18	30	5	55	90	1	1	16	18	2	0	6	8	-	-	-	-	3	1	22	26	33	6	77	46
2. Government Sector	0	1	4	5	0	5	20	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	5	20	25
3. Money and Interest Rates	1	0	7	8	5	0	35	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0	35	40
4. Prices and Supply	2	2	8	12	10	10	40	60	0	1	10	11	0	0	2	2	-	-	-	-	0	1	12	13	10	11	52	73
5. International Account	0	0	6	6	0	0	30	30	0	0	5	5	0	0	1	1	-	-	-	-	0	0	6	6	0	0	36	36
6. International Trade and Prices	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	15	18	1	2	15	18	1	2	15	18
TOTAL of Sectors	9	4	36	49	45	20	180	245	1	2	31	34	2	0	9	11	1	2	15	18	4	4	55	63	49	24	235	308

B = Behavioral
E = Empirical
D = Definitional
T = TOTAL

There are 49 behavioral equations of which 45 are in the industrial country blocks and the remaining four in RW block. The majority of the equations, 235 to be precise, are definitional and include accounting identities, mathematical transformations of variables, and equations defining variables. The remaining 24 equations are empirical relations incorporating proportionality of one variable with respect to another. There are 414 estimated coefficients and parameters and 64 exogenous variables.

The behavioural equations were estimated using ordinary least wquares. The estimation period varies, but is generally 1965-1986. The variables differ widely in their respective units of denomination across countries because of differing currency units.

F. Dynamic Structure

In order to identify and understand the major sources of dynamics in the model, we provide a brief discussion of the dynamic specification of equations included in each of the five sectors of the model.

Among the equations in the aggregate demand sector, the consumption, investment, and import equations include a lagged endogenous variable. Some monetary variables enter the wealth determination equation with lags, for example, net foreign assets (with a one-period lag) and long-run interest rate (as a three-period moving average).

In the government sector the dominant source of dynamics is the private sector holdings of government bonds (B), which influences endogenous variables of the sector with a one-period lag.

What distinguishes MULTIMOD from conventional models is the additional sources of dynamics which stem from the forward-looking nature of inflation rate, long-run interest rate and exchange rate variables in certain equations.

The role of the monetary sector in underpinning the dynamic behavior of the model is crucial. In this sector, the sources of dynamics originate primarily from the short-term and long-term interest rates, and the inflation rate. The one-period lagged short-term interest rate influences the demand for and the supply of money base. The dynamic influence of long-term

interest rate is both forward and backward. It enters the term structure of interest rates with a one-period lead, while it is an argument of the "average interest rate" variable as a three-period moving average. Some additional sources of dynamics in this sector derive from the inflation rate. It is used with a one-period lead in converting nominal interest rates into real rates and in the determining of user cost of capital.

The prices and supply sector derives much of its dynamic behavior from the use of a one-period look-ahead for inflation and one-period lags for some of the endogenous variables, such as, capacity utilization (CU), net foreign assets (NFA), and absorption deflator (P).

The international accounts sector consists of six identities. The only sources of dynamic behavior in this sector are net foreign assets with a one-period lag in the balance of payment identity and exchange rate with a one-period lead in the interest parity equation.

III. Evaluation of the Model

The evaluation of MULTIMOD is divided into three parts. In the first part, the forward-looking properties of the model are reviewed and compared with those of some other macroeconometric models. In the next part, we investigate how the responses of the model to monetary and fiscal policy shifts match up against the results of macroeconomic theory. In the third part of the section, we consider the relevance of the model for the analysis of issues concerning the developing countries.

A. Rational Expectations and MULTIMOD

1. Rational Expectations in Macroeconometric Modelling

The traditional approach of applying decision theory to the formulation of optimum macroeconomic policy lost its validity, in the eyes of many analysts, because it failed to give any weight to future policy actions in the selection of solutions to the current problems. This omission renders the process of optimal decision-making a repetitive act requiring constant revaluation with the appearance of new policies, rather than making it a deterministic function of all information available to the decision maker.[13]

According to Sims (1982), the application of control theory to econometric models misses the point that "People's current economic choices depend not only on the actual values of variables entering an econometric model, but on their expectations about future values of those variables." Therefore, the argument goes, conventional econometric models, which make no provision for examining the effects of the public's views about plans for future policy choices, are counter-

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[13] Sims C. (1982). "Policy Analysis with Econometric Models." Brookings papers on Economic Activity, 1:1982 pp. 107-164.

productive and the alternative suggested by the critiques is the use of rational expectations assumption in policy analysis models. In rational expectations models, on the other hand, the expectation formation mechanism is forward-looking. For example, the consequences of anticipated and unanticipated inflation are different in a rational expectation model, whereas in conventional models the distinction between the two has no operational significance. Therefore, one way of understanding the internal properties of a rational expectation model is to examine whether the expectation formation mechanism of the model is responsive to policy changes.[14]

2. The Comparison of Anticipated with Unanticipated Shocks

For purposes of illustration, we present in Table 3, simulation results comparing the impact of a four percent increase in the United States target level of monetary base, announced three years in advance, with the effects of a one-time unanticipated four percent increase.

The simulations for both the anticipated and the unanticipated cases start from 1988, but in the former case the increase in monetary base enters the computation three years after the start of simulation.

The results provided in Table 3 indicate that the responses of the model to an anticipated increase in the U.S. monetary base is significantly different from its responses to an unanticipated increase.[15] Although the directions of change are very similar in both the cases for a given variable, the degree of fluctuation between the first year of the simulation and the last year is generally smaller when the shock was anticipated. Thus, an unanticipated shock is more powerful,

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[14]An additional procedure to test the significance of forward-looking properties of a rational expectations model would be to compare the responses of the model when the rational expectations assumption for the formation of some variables is replaced by an "autoregressive expectations" hypothesis. Under the latter regime, expectations of a variable are based only on its current and lagged values. Ray Fair (1987), performed such a test for his model and found no strong evidence in favor of rational expectations hypothesis. He concluded that policy properties of the model are not very sensitive to its use. On the other hand, Helliwell, *et al*, (1988b) demonstrated that the response of their model, INTERMOD, would be substantially different when they alternate between forward-looking and adaptive expectations for the same shock.

[15]Fiscal policy changes is negative on impact if anticipated.

Table 3

EFFECTS OF A FOUR PERCENT
INCREASE IN THE U.S. MONEY SUPPLY IN MULTIMOD

YEAR	United States (US)								Japan (JA)							
	GNP		PGNP		RS[a]		MERM		GNP		PGNP		RS[a]		MERM	
	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN
1988	.59	.28	.08	.08	- .74	.[illegible]	-1.97	-1.55	- .14	- .10	0	- .03	- .05	- .04	.92	.73
1989	.46	.33	.20	.25	- .70	.15	-1.45	-1.48	- .15	- .09	0	- .06	- .05	- .05	.68	.71
1990	.30	.30	.36	.48	- .71	.19	- .97	-1.50	- .07	- .07	0	- .07	- .02	- .04	.46	.74
1991	.17	.26	.49	.75	- .73	- .62	- .54	-1.60	- .01	- .06	.05	- .03	.01	- .03	.27	.80
1992	.05	.16	.59	1.02	.11	- .59	- .12	-1.27	0.03	- .06	.11	.05	.04	- .05	.09	.66
1993	.08	.04	.64	1.23	.13	- .57	- .22	- .98	0.06	0	.16	.17	.06	.04	.15	.52
1994	.07	- .05	.65	1.37	.11	- .57	- .32	- .68	0.01	.02	.20	.29	.05	.08	.21	.38
1995	.04	- .14	.63	1.47	.12	.25	- .43	- .36	-0.03	.02	.19	.37	.04	.11	.26	.23

YEAR	Germany (GR)								Other Large Industrialized Countries (LI)							
	GNP		PGNP		RS[a]		MERM		GNP		PGNP		RS[a]		MERM	
	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN	UN	AN
1988	- .16	- .12	0	- .02	- .08	- .06	.52	.43	- .11	- .06	.02	- .01	- .03	- .01	.54	.41
1989	- .08	- .05	.02	- .03	- .03	- .05	.38	.40	- .10	- .09	.06	- .01	- .02	- .02	.40	.42
1990	.03	0	.07	- .01	.03	- .01	.25	.38	- .05	- .11	.12	0	.05	- .02	.28	.45
1991	.07	.03	.17	.07	.06	.02	.12	.37	0	- .12	.18	.08	.03	- .01	.16	.50
1992	.07	.02	.26	.21	.09	.05	.01	.28	.04	- .07	.23	.19	.05	.01	.04	.41
1993	.05	.04	.34	.36	.10	.11	.03	.21	.02	0	.25	.31	.05	.05	.06	.32
1994	- .04	.02	.36	.50	.08	.14	.06	.14	- .03	.05	.26	.42	.04	.07	.09	.22
1995	- .08	.02	.32	.58	.07	.15	.10	.08	- .05	.08	.20	.48	.03	.09	.12	.11

YEAR	Small Industrialized Countries (SI)							
	GNP		PGNP		RS[a]		MERM	
	UN	AN	UN	AN	UN	AN	UN	AN
1988	- .05	- .03	.02	0	- .03	- .02	.63	.50
1989	- .08	- .07	.06	0	- .01	- .02	.46	.45
1990	.02	- .04	.10	.03	.02	0	.30	.43
1991	.08	- .02	.18	.11	.05	0	.16	.43
1992	.10	.03	.25	.23	.06	.04	.03	.33
1993	.04	.08	.29	.36	.06	.08	.05	.24
1994	- .04	.08	.29	.46	.04	.09	.08	.16
1995	- .09	.06	.25	.51	.02	.09	.11	.08

All figures are in percentage deviation from the baseline, unless otherwise noted. Any value below 0.01 is given as zero.

[a]The figure is percentage point change from the baseline.

-AN = Anticipated
GNP = Real Growth National Product
MERM = MERM Effective Exchange Rate
PGNP = GNP Price Deflator
RS = Short Term Nominal Interest Rate
UN = Unanticipated

contemporaneously, than an anticipated shock, but has a less lasting effect. For example, the changes in the GNPs are much larger in the case of the unanticipated shock. In both the cases, the expansionary monetary policy in the United States initially increases its own GNP and reduces other countries' GNPs. Among the industrialized blocks, Japan showed stronger reaction to the monetary changes in the United States than others. The changes in the GNPs gradually return to their normal position as the prices adjust.

3. MULTIMOD and Other Rational Expectations Models

The above results are in broad conformity with the the results of simulations performed with John Taylor's Multi-Country Model using the same assumptions (Table 4). Two points of difference between the two models, however, may be noted:[16] First, Taylor's results show larger increases in GNP deflators for the unanticipated monetary shock, while the MULTIMOD results show the reverse for all countries and regions. An implication of the rational expectations hypothesis is that when a policy change (e.g., a monetary expansion) is expected to take place in some distant future (i.e., anticipated) and is taken into account in current policy evaluations, prices respond in advance of the policy changes. In other words, prices should rise faster in the case of anticipated shocks.

The second point of difference between the results of the two models is that prices in the United States are more responsive to a monetary expansion (anticipated or unanticipated) in Taylor's model than in MULTIMOD. However, higher output growth rates for Taylor (both for anticipated and unanticipated) might be only due to the difference in initial conditions.[17]

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[16]Taylor, John B. "The Treatment of Expectations in Large Multi-Country Econometric Models," in Bryant, Ralph C., *et al*, (Eds.) *Empirical Macroeconomics for Interdependent Economics*, The Brookings Institution, 1988, p. 161-182.

[17]The time periods for the shocks reported in table 3 for MULTIMOD are different from the time periods in used for shocks in table 4 for Taylor's model.

TABLE 4

EFFECTS OF A 4 PERCENT, ONE-TIME INCREASE IN THE U.S. MONEY SUPPLY
IN THE TAYLOR MULTI-COUNTRY RATIONAL EXPECTATIONS MODEL

(Percent Change from Baseline Unless Otherwise Noted)

YEAR	United States				Japan				ROECD			
	GNP	PGNP	RS[a]	E[b]	GNP	PGNP	RS[a]	E[b]	GNP	PGNP	RS[a]	E[b]
Increase Unanticipated												
1985	0.83	0.23	-0.61	-4.1	0.01	-0.01	-0.01	4.4	0.04	0.02	0.02	4.2
1986	0.50	0.85	-0.50	-3.4	-0.08	-0.08	-0.02	3.7	-0.06	-0.10	-0.10	3.6
1987	0.45	1.42	-0.34	-3.1	-0.21	-0.22	-0.05	3.3	-0.11	-0.23	-0.23	3.2
1988	0.33	1.83	-0.31	-2.9	-0.31	-0.41	-0.07	3.1	-0.13	-0.36	-0.36	3.0
1989	0.19	2.11	-0.30	-2.7	-0.31	-0.61	-0.08	2.8	-0.12	-0.46	-0.46	2.8
1990	0.13	2.27	-0.29	-2.5	-0.24	-0.76	-0.08	2.6	-0.07	-0.52	-0.52	2.6
Increase Anticipated Three Years in Advance												
1985	0.32	0.12	0.12	-2.5	-0.01	-0.01	-0.01	2.7	0.00	-0.02	-0.02	2.5
1986	0.37	0.50	0.24	-2.7	-0.07	-0.07	-0.02	2.8	-0.04	-0.08	-0.08	2.7
1987	0.46	0.99	0.36	-3.0	-0.16	-0.18	-0.03	3.2	-0.08	-0.17	-0.17	3.1
1988	0.45	1.48	-0.44	-3.2	-0.23	-0.34	-0.05	3.4	-0.10	-0.29	-0.29	3.3
1989	0.26	1.85	-0.39	-2.8	-0.27	-0.51	-0.07	2.9	-0.12	-0.40	-0.40	2.9
1990	0.18	2.08	-0.31	-2.6	-0.25	-0.67	-0.07	2.7	-0.09	-0.48	-0.48	2.6

Source: John B. Taylor in R. C. Bryant et al (1988).

[a]Percentage-point change from baseline short-term interest rate.
[b]The exchange rate, measured as weighted units of foreign exchange per unit of domestic currency.

4. Application of Rational Expectations to Developing Countries

Max Corden (1987) discusses the application of rational expectations hypothesis to developing countries within a Keynesian framework. According to him, if we accept the argument of rational expectations theorists, changes in nominal demand are always fully anticipated by private agents. Therefore, if prices and wages are flexible in response to market conditions, one should not expect nominal demand policies to cause changes in real output, because market will be cleared rapidly after each stimulation. The performance of rational expectations theory depends on a number of factors: flexibility of prices and wages, the consistency of government rules and systematic policies, and the availability of new information to help the private agents in the formation of their expectations.

The first factor, flexibility of wages and prices in macroeconometric models of the developing countries, has been handled by a number of economists in the context of a Keynesian framework. It usually means some rigidity and sluggishness in the adjustment of wages and prices (Khan and Knight, 1981). However, it has also been argued that, due to weaker labor organizations, prices and wages are more flexible in the developing countries than in the industrial countries. As a result, nominal Keynesian demand policies are expected to be ineffective. Whatever the truth, generalization of theoretical results to the developing countries needs many qualifications and has to be handled with a lot of care.

The second factor is the extent to which government rules and policies in the developing countries are systematic and predictable as well as the extent to which private agents are informed about government actions. This again would vary from country to country. However, between the two, as Corden stated, "... taking all the inevitable variety into account, the weight given in the macroeconomic literature to private agents reactions to systematic government policies seems out of proportion in the context of developing countries."

The third important factor in the formation of expectations in the developing countries, namely, the availability of new information. The strength and effectiveness of government policies

in manipulating private agents' demand depends on the extent of their information and use of this information. Experience has shown that information, in the developing countries, is expensive, difficult to obtain, and not available to all private agents. Therefore, the prospects for the prediction of government policies by the private agents in forming their expectations are dim.

To conclude, the structural characteristics and the degree of price and wage rigidities vary widely in the developing countries, as does the consistency of government rules and policies. Further, information is scarce and not widely available. Under these circumstances, no generalizations can be arrived at with respect to the application of the rational expectation theory to the developing countries. In particular, aggregation of developing countries into a block in a multiregional macroeconometric model is controversial, to say the least. Second, the decision-making by private agents in the developing countries is *not* based on the fullest possible information set regarding the future, and hence, governments' nominal demand management policies can have real effects in the short-run. Finally, these factors limit the application of rational expectation theory to the developing countries' macroeconometric models, and very likely, complicate the interpretation of the results.

Coming to the implementation of rational expectations framework in the developing country block in MULTIMOD, the model relates the availability of new funds to the developing countries to the "debt-interest-to-export ratio evaluated at the expected real interest rates and export revenues in the future." This specification requires a four period advance knowledge of export revenues. However, developing country exports are imports of the industrialized countries which their values are simultaneously determined in the industrialized blocks. Thus, specification in MULTIMOD avoids the shortcomings and complications enumerated above.

B. Model Responses to Policy Shocks

Generally, multi-country macroeconometric models react differently to fiscal and monetary policy shocks. Both theoretical specifications, and magnitudes of empirical coefficients are responsible for the differences. In the following, the responses of MULTIMOD to policy shocks are analyzed

and are compared with those of other models. In this analysis we are particularly interested in knowing how the presence of forward-looking variables in MULTIMOD influences the responses of the model to the shocks. We start with a brief recapitulation of the effects on the economy of various policy changes according to macroeconomic theory. Next, we briefly review the treatment of the financial market in MULTIMOD as an aid in understanding the simulation results. In part three, the responses of the model to monetary and fiscal shocks are analyzed.

1. Some Theoretical Considerations

We start by considering the expected effects on income, interest rate, exchange rates, and balance of payments of an exogenous increase in government spending (G) in an open economy, under a flexible exchange-rate regime. The rise in government expenditure increases aggregate demand, shifts the IS curve (the combination of interest rates and levels of income for which the goods markets clear) to right, and increases interest rates. The effect on the balance of payment components and the exchange rate depends on the degree of capital mobility.[18] If capital is

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[18] Suppose, demand for money is determined as a positive function of income, (y), and negative function of interest rate, (i).

$$\frac{M}{p} = L(y,i) \qquad L_y > 0, \quad L_i < 0$$

Then, the slope of the LM curve is:

$$\left.\frac{di}{dy}\right|_{LM} = -\frac{L_y}{L_i} > 0,$$

Also, the trade balance, T, is a function of income and exchange rate e, and the capital flow, K, is a function of the differential between domestic interest rate and foreign interest rate, i^*:

$$T = T(y,e)$$
$$K = K(i - i^*), \qquad K_{i-i^*} > 0$$

The slope of the BP schedule (the locus of the balance of payments equilibria) is:

$$\left.\frac{di}{dy}\right|_{BP} = -\frac{dT/dy}{dK/di} > 0$$

In case of perfect capital mobility, $\left.\frac{di}{dy}\right|_{BP} = 0$, and in case of perfect capital immobility, $\left.\frac{di}{dy}\right|_{BP} = \infty$.

perfectly immobile between countries, there is no interest-rate effect on the capital account, the trade balance deteriorates and the currency depreciates. Otherwise, the effect on the balance of payments and exchange rate depends on the slopes of LM curve (the combination of interest rates and levels of income for which the money market clears) and BP curve (the locus of balance of payments equilibria). The higher the degree of capital mobility (that is, the lower the slope of BP), and the higher the increase in interest rate after a rise in income (that is, the steeper the LM curve), the higher would be the improvement in the capital account after an increase in aggregate demand, but the effect on exchange rate remains indeterminate.

The effect of an expansionary monetary policy is less ambiguous than that of an expansionary fiscal policy: an increase in money supply increases output and reduces interest rate. The interest rate differential, in the case of high capital mobility, increases capital outflow and depreciates currency. Lower exchange rate, in turn, improves the trade balance by lowering imports and increasing foreign demand for exports. In summary, if the Marshall-Lerner condition is satisfied the net effect on external balances would be positive.

2. The Financial Market in MULTIMOD

The specification of financial market and the values of the estimated coefficients are important factors in interpreting the simulations results of any model. In MULTIMOD, the demand for real money balances is determined jointly by an "activity variable," (GNP), and by the short-term interest rate. Long-term interest rates are determined by a term structure relationship that equalizes the holding period yield on short- and long-term assets. The slope of the LM curve in the long run, which has special significance for the analysis, and which is determined as a ratio of income elasticity to interest rate semi-elasticity (0.97/0.07), is constrained to be the same across the industrialized countries.[19] This feature of the model rules out attributing the variation of

[19]See Helliwell (1988) for a comparison of the slopes of the LM curve in other models.

responses across different industrialized countries simply to the differences in the slopes of LM curves.

MULTIMOD assumes perfect substitutability of assets, that is, infinite elasticity of capital movements with respect to the changes in the interest rate. Thus, there is no international demand for domestic assets. The domestic and foreign interest rates are perfectly correlated, and any deviation among them would be corrected by the movements of future exchange rates rather than by the changes in demand for assets. This is shown in equation (1).

$$(1 + USRS) = (1 + RS^*)\,(ER_{+1}/ER) \qquad (1)$$

where:

USRS is the U.S. short-term interest rate,
RS^* is the short-term interest rate for a given industrial country,
ER is the dollar rate of the currency of that country, and
ER_{+1} is ER with a one-period lead (the future exchange rate).

The above equation shows the uncovered interest parity condition for the nominal short-term interest rates of the U.S. and a given industrial country block. In addition, by rewriting the equation as shown in (2), we see how MULTIMOD solves for future exchange rate values:

$$ER_{+1} = [(1 + USRS)/(1 + RS^*)]\,ER \qquad (2)$$

With perfect asset substitution, the BP curve is horizontal (see Footnote 15). This is an important structural feature of MULTIMOD which should be kept in mind while interpreting the model's response to policy shocks, especially fiscal ones, and while comparing its simulation results with those of the other models.

3. International Transmission of Fiscal Policy Effects

Table 5 summarizes the results of simulating the impacts of an unanticipated fiscal policy shock originating respectively in the U.S., Germany, Japan, and the large industrialized countries block (LI). In each case, the real government expenditures in the respective block increased by one percent of real GNP for five years, beginning in 1988. The results on the shock-originating

economies are given in the main table and the cross country effects of each shock are reported in Appendix A (Tables A1 through A4).

As may be seen in Table 5, the model responses are consistent with theoretical expectations outlined in Section III.B.1. In each case, income and prices increased, currencies appreciated, and current account balances deteriorated. These responses proved to be highly symmetrical and comparable in magnitude. This is in contrast to the responses of some other multiregional macroeconometric models as reported by Helliwell (1988), Hickman (1988) and Frankel (1988). For example, Frankel (1988) found asymmetry between the exchange rate effects of the U.S. fiscal expansion and European or Japanese expansion in the results obtained from EEC, EPA and VAR models. For other models, Bryant (1988) found that "fiscal multiplier effects were more short lived in the U.S. than in the rest of the OECD (ROECD), and second the current account and foreign GNP effects of U.S. fiscal policies were greater than for ROECD policies, despite the fact that the ROECD is 50 percent larger than the United States."[20]

These asymmetries are often attributed to the steeper LM curve and greater capital mobility in the United States. This suggests that the symmetric response of MULTIMOD is due mainly to identical LM curves and perfect capital mobility in all the industrialized countries or regions.

The impact of expansionary fiscal policies on the respective economies themselves, are displayed graphically in Figure 1. The countries reach the peak of their GNP growth in the second period of simulation. The fiscal expansion has less impact on output growth in Germany than in other countries. Beyond the second period, increasing prices and interest rates gradually offset the positive impact of fiscal expansion on output. In this phase, the rate of decline of GNP growth is smaller for the U.S. than for other countries. The moderate response of Germany's output growth is accompanied by a moderate rise in prices and interest rate, whereas the more powerful U.S. response stimulates higher domestic inflation and higher interest rates. The higher inflation in the

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[20]See Appendix A for comparable results obtained in experiments with MULTIMOD, and Helliwell (1988) for further discussion.

Table 5

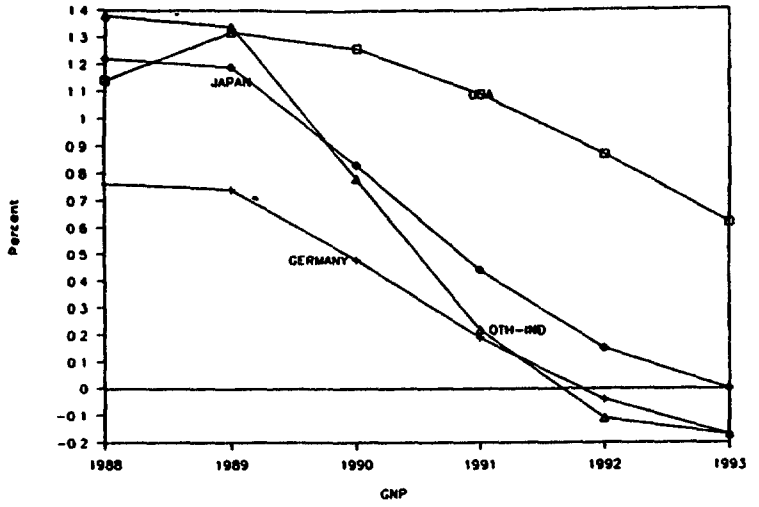
EFFECTS OF A FIVE YEAR SUSTAINED INCREASE IN REAL GOVERNMENT EXPENDITURES BY ONE PERCENT OF REAL GNP, ON THE ECONOMY OF THE SHOCK ORIGINATING REGION

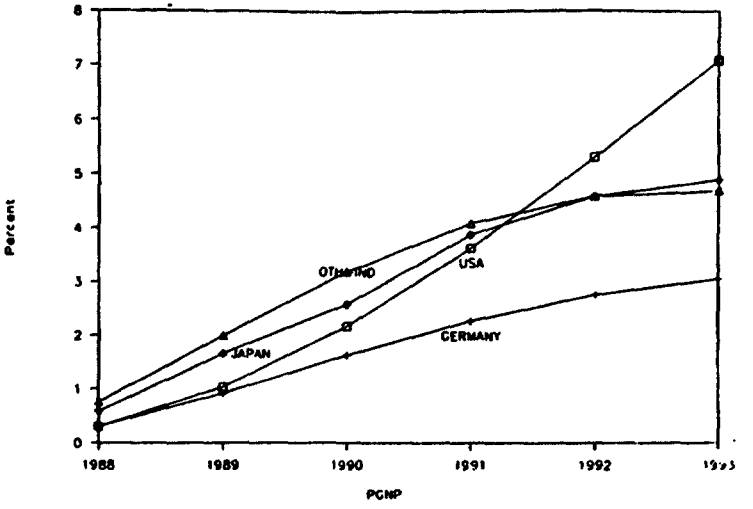
PERIODS	United States					Germany					Japan					Other Large Industrialized Countries				
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL
1988	1.14	0.30	2.11	0.16	-11.46	0.76	0.32	1.08	0.11	-5.43	1.22	0.59	1.37	0.21	-5.01	1.38	0.77	0.63	0.25	-6.79
1989	1.32	1.04	2.00	0.27	-16.62	0.74	0.92	0.99	0.18	-6.70	1.19	1.66	1.22	0.33	-8.09	1.34	1.99	0.44	0.40	-13.29
1990	1.26	2.17	1.89	0.41	-21.49	0.48	1.63	0.83	0.23	-7.26	0.83	2.58	0.96	0.43	-10.41	0.78	3.19	0.17	0.47	-19.25
1991	1.09	3.63	1.78	0.56	-27.98	0.19	2.27	0.63	0.27	-7.72	0.44	3.88	0.64	0.50	-12.80	0.22	4.09	-0.11	0.51	-24.87
1992	0.87	5.31	1.64	0.74	-35.46	-0.04	2.76	0.41	0.29	-8.31	0.15	4.58	0.27	0.55	-15.23	-0.11	4.58	-0.37	0.53	-29.87
1993	0.62	7.09	1.43	0.91	-44.33	-0.17	3.06	0.17	0.31	-9.10	0	4.89	-0.09	0.57	-17.29	-0.17	4.69	-0.59	0.55	-29.82

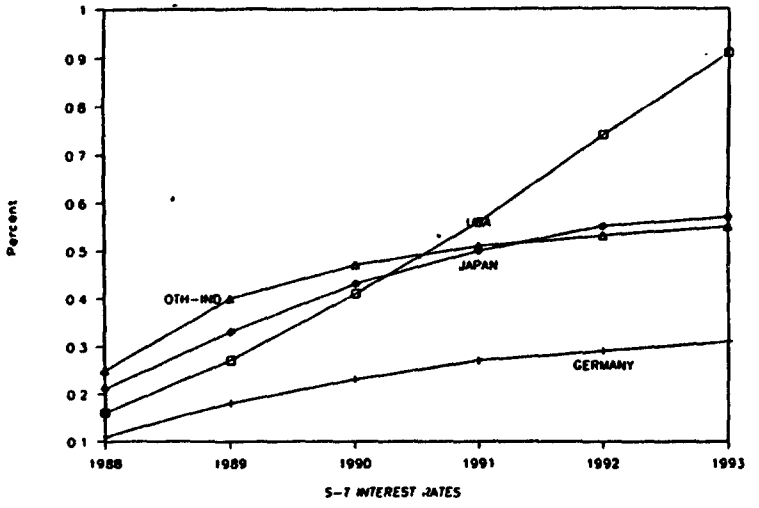
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance

- The figures for GNP, PGNP, MERM and ER are percentage deviation from the baseline.
- RS is the change in the percentage level.
- CURBL is in billions of dollars.

Responses of OWN GNP, PGNP, Short-Term Interest Rate After an Expansion in Real Government Expenditures for Japan, Germany, U.S. and Large Industrialized Countries







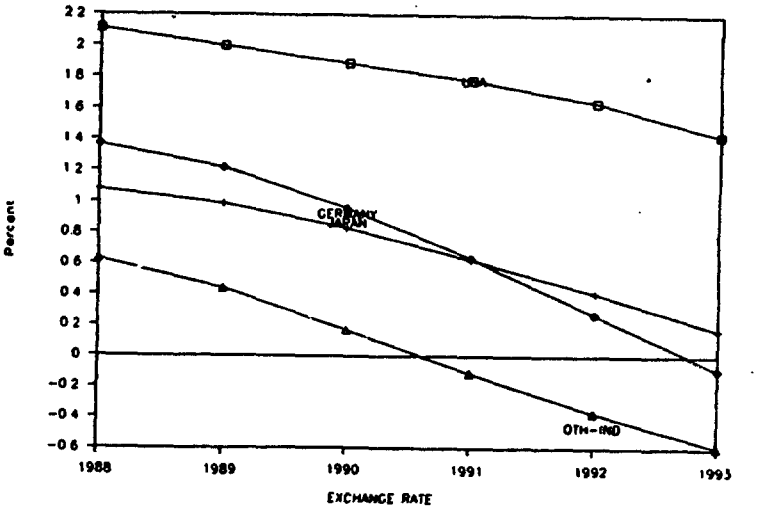


FIGURE 1

- The figures for GNP, PGNP, and exchange rate are percentage deviation from the baseline.
- The figures for short-term interest rate are change in the percentage level.

U.S. raises nominal interest rate and reduces real money supply. Lower real money supply, in turn, pushes interest rates even higher.

The results for other models for a US fiscal expansion, reported by Frankel (1988), are similar to MULTIMOD for many of the variables given in Table 5, except for the depreciation of the U.S. dollar in the LINK model. This difference is attributable to there being little or no capital mobility in the LINK model and to its highly elastic LM curve for the U.S.[21]

The spillover effects of the government expenditure expansions are presented in Tables A1 through A4 in Appendix A. These effects indicate that the impact of a fiscal expansion on a non-originating blocks is similar to, but smaller than, that on the originating block. A fiscal expansion in a given block stimulates domestic output, raises domestic prices and, because of rising demand for imports from non-originating blocks, leads to deteriorating current account balances. In the non-originating blocks, the higher export demand for their output stimulates growth and raises their domestic inflations. But, their rates of inflation and, consequently, their nominal interest rates remain lower than their counterparts in the originating block. As can be seen in the Tables in the Appendix, these results hold symmetrically, whichever be the shock-originating block.

In contrast, the impact on the exchange rate of the non-originating blocks is ambiguous. This is due to the two opposing forces that operate on the exchange rates. Higher interest rates in the originating blocks put a downward pressure on the exchange rate movements of the non-originating blocks, while the current account deficits put an upward pressure. The net impact would depend on the degree of capital mobility and export share distribution of the individual non-originating blocks.

In sum, an increase in government expenditures in a given block stimulates output, raises prices, and improves current account balances of other blocks, the effect on their exchange rates remaining ambiguous.

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[21]Hickman (1988, Table 5.1) reports that, among the 12 multi-country models studied by him, LINK has the most elastic LM curve for the U.S.

Finally we briefly touch upon the differences between rational expectations models and conventional models in terms of their responses to a fiscal expansion in a major country. In the former class of models, one would expect a fiscal expansion to lead to faster and sharper adjustments in exchange rates and prices and a larger deterioration of current account balance. This is confirmed by Table 6 where the results obtained using MULTIMOD are shown along with those obtained using other models (Frankel, 1988, Table 2.2). The changes in real output and current balances are not very different across models, but the change in prices is higher with MULTIMOD than with other models.

4. International Transmission of Monetary Policy Effects

Table 7 summarizes the results of simulating the impacts of an unanticipated monetary policy shock originating respectively in the U.S., Germany, Japan, and the large industrialized countries block (LI). In each case, the target stock of monetary base for the given country or region is subjected to a sustained increase amounting to four percent of the money supply.

As can be seen from the table, the monetary expansions produce similar effects over time in the respective economies of the shock-originating block. Initially, a rise in money supply reduces interest rates, and increases output and prices. Lower interest rates cause the currency to depreciate and capital outflows to increase, thus leading to improved trade balances. Over time, rising inflation reverses this trend. In the medium-term, the decline in interest rate slows down, the depreciation of exchange rate decelerates, and the current account improves less vigorously. In the long-run, the model returns to the baseline level of output with higher prices and depreciated exchange rates.

These trends are charted in Figure 2. It may be seen that the directions of change are very similar but the magnitudes differ, especially with respect to exchange rates. There are two notable exceptions, however. First, in the case of the U.S., the fast-ascending trends in exchange rate and short-term interest rate coupled with the slowly-descending trend in output indicate that the cycle of changes is more prolonged in the U.S. economy. Second, while the growth of output generally

TABLE 6

SIMULATION EFFECTS IN THE SECOND YEAR OF AN INCREASE IN THE U.S. GOVERNMENT EXPENDITURE OF ONE PERCENT OF GNP

Percent Except for Interest Rates in Percentage Points and Current Account in Billions of Dollars

Fiscal Expansion by Model*	Output	Consumer Price Index	Short-Term Interest Rate	Currency Value	Current Account
DRI	2.1	0.4	1.6	3.2	-22.0
EEC[a]	1.2	0.6	1.5	0.6	-11.6
EPA[b]	1.7	0.9	2.2	1.9	-20.5
LINK	1.2	0.5	0.2	-0.1	-6.4
LIVERPOOL	0.6	0.2	0.4	1.0	-7.0
MCM	1.8	0.4	1.7	2.8	-16.5
MINIMOD	1.0	0.3	1.1	1.0	-8.5
MSG	0.9	-0.1	0.9	3.2	-21.6
OECD	1.1	0.6	1.7	0.4	-14.2
TAYLOR[c]	0.6	0.5	0.3	4.0	N/A
VAR[c]	0.4	-0.9	0.1	1.2	-0.5
WHARTON[d]	1.4	0.3	1.1	-2.1	-15.4
MULTIMOD[d]	1.32	1.04	0.3	2.0	-16.6

SOURCE: Frankel (1988), and MULTIMOD.

N/A Not Available

* The list of these models are explained in APPENDIX D.

a ROECD short-term interest rate not available; long-term reported instead.

b ROECD current account is Japan, Germany, the U.K., and Canada.

c CPI not available; GNP deflator reported instead.

d Government shock not a permanent shock, sustained for only five years.

Table 7

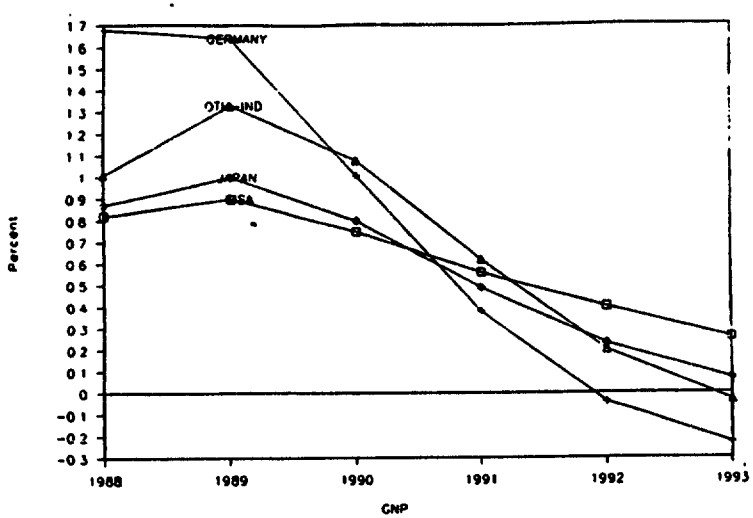
EFFECTS OF FOUR PERCENT SUSTAINED INCREASE IN MONEY BASE TARGET, ON THE ECONOMY OF SHOCK ORIGINATING REGIONS

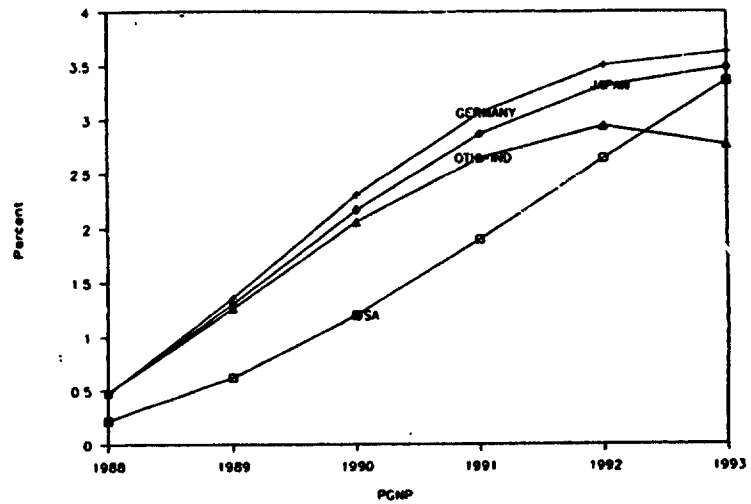
PERIODS	United States					Germany					Japan					Other Large Industrialized Countries				
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL
1988	0.82	0.22	-4.48	-0.34	4.96	1.68	0.47	-4.38	-0.15	-0.41	0.87	0.48	-4.43	-0.31	1.32	1.01	0.48	-3.90	-0.27	2.90
1989	0.90	0.62	-4.11	-0.28	5.79	1.64	1.36	-4.19	-0.06	-0.59	1.00	1.30	-4.14	-0.19	2.68	1.33	1.26	-3.73	-0.14	6.73
1990	0.75	1.20	-3.86	-0.24	5.87	1.01	2.31	-4.10	-0.05	-0.20	0.80	2.17	-4.09	-0.12	3.11	1.08	2.06	-3.71	-0.08	7.68
1991	0.56	1.90	-3.70	-0.18	5.38	0.38	3.06	-4.05	-0.05	0.75	0.49	2.87	-4.18	-0.07	3.07	0.62	2.65	-3.74	-0.08	7.95
1992	0.40	2.64	-3.61	-0.12	4.50	-0.04	3.50	-4.03	-0.07	1.58	0.23	3.31	-4.33	-0.05	2.89	0.20	2.94	-3.78	-0.10	7.89
1993	0.26	3.36	-3.58	-0.05	3.24	-0.23	3.63	-4.01	-0.08	2.03	0.07	3.48	-4.47	-0.05	2.64	-0.03	2.77	-3.80	-0.13	7.78

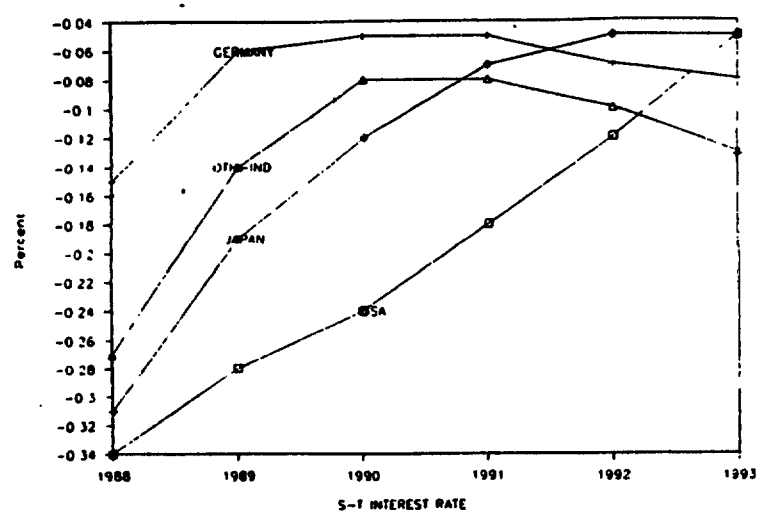
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL is in billions of dollars.

Response of Own, GNP, PGNP, Short-Term Interest Rate, and Exchange Rate After a Four Percent Sustained Increase in Money Base Target of the U.S., Germany, Japan and Other Industrialized Countries







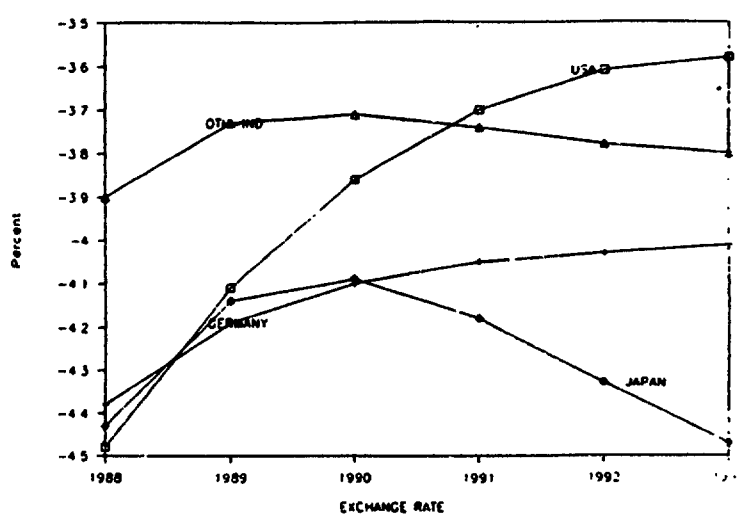


FIGURE 2

- The figures for GNP, PGNP, and exchange rate are percentage deviation from the baseline.
- The figures for short-term interest rate are change in the percentage level.

reaches a peak in the second period, in the case of Germany (which has the largest multiplier effect on impact) output falls beyond the first period, and the fall is sharper than for other blocks. Further, even though monetary expansion generally has a positive impact on current account balances, Germany's current account reacted with a prolonged J-curve and did not improve until the fourth period.

Figure 2 shows the relative impacts of fiscal and monetary expansions on the economies of the U.S. and Germany. The output response for a fiscal expansion was stronger for the U.S. than for Germany. Conversely, Germany's growth of output reacted relatively more strongly to monetary expansion as did the German rate of inflation. The growth of output in the U.S., however, increased relatively less in response to a monetary expansion. This suggests that the U.S. economy is more responsive to fiscal expansions, whereas Germany's economy, due to its higher degree of openness measured by import/GNP ratios, is more responsive to monetary shocks.

The cross-country effects of the monetary shocks, shown in Tables A5 through A8 in the Appendix, follow the Mundell-Fleming story: domestic monetary expansion leads to the depreciation of shock-originator's currency, worsens current balances, and reduces foreign outputs.[22] In all four cases, output and price increased in the shock-originating block and fell in all the non-originating blocks. Also, the non-originating country's current balances generally worsened, with the exception of Germany and Japan which improved their current balances at the expense of the large industrialized countries (the LI block), when the expansion originated from the U.S. (see Table A5 of the Appendix.

Table 8 compares the responses of MULTIMOD to the monetary expansion with those of John Taylor's model and the Liverpool model (Bryant 1988). Figures 3 through 5 show the responses graphically for the U.S., Japan, and LI, respectively. The responses of MULTIMOD and Taylor's model are similar but that of the Liverpool model is very different from the other two. For example, the U.S. own inflation rates are much higher in the Liverpool model than in the other

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[22]See Mundell, 1964.

Table 8

THE IMPACT OF FOUR PERCENT INCREASE IN THE U.S. MONEY SUPPLY IN MULTIMOD (MULTI), TAYLOR, AND LIVERPOOL (LIVPL) MODELS

USA

	GNP			PGNP			EXCHR			RS		
	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL
1985	0.68	0.83	0.60	0.20	0.23	1.80	-4.29	-4.10	-2.20	-0.37	-0.61	0.40
1986	0.82	0.50	0.10	0.59	0.85	3.70	-5.01	-3.40	-3.90	-0.30	-0.50	-0.30
1987	0.69	0.45	-0.10	1.15	1.42	3.90	-4.34	-3.10	-4.00	-0.25	-0.34	-0.10
1988	0.56	0.33	-0.20	1.83	1.83	4.10	-3.98	-2.90	-4.10	-0.19	-0.31	-0.10
1989	0.39	0.19	-0.20	2.56	2.11	4.40	-3.72	-2.70	-4.30	-0.12	-0.30	0.00
1990	0.22	0.13	-0.20	3.29	2.27	4.50	-3.55	-2.50	-4.40	-0.06	-0.29	0.00

JAPAN

	GNP			PGNP			EXCHR			RS		
	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL
1985	-0.36	0.01	0.00	-0.09	-0.01	-0.20	4.33	4.40	2.40	-0.07	-0.01	-0.20
1986	-0.43	-0.08	0.00	-0.26	-0.08	-0.10	5.10	3.70	4.30	-0.10	-0.02	-0.10
1987	-0.28	-0.21	0.00	-0.40	-0.22	0.00	4.43	3.30	4.30	-0.10	-0.05	0.00
1988	-0.10	-0.31	0.00	-0.41	-0.41	0.00	4.07	3.10	4.40	-0.07	-0.07	0.00
1989	0.05	-0.31	0.00	-0.31	-0.61	0.00	3.81	2.80	4.60	-0.03	-0.08	0.00
1990	0.13	-0.24	0.00	-0.09	-0.76	0.00	3.67	2.60	4.60	0.00	-0.08	0.00

ROECD/I.T[a]

	GNP			PGNP			EXCHR			RS		
	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL	MULTI	TAYLOR	LIVPL
1985	-0.34	0.04	0.10	-0.14	0.02	-0.10	4.46	4.20	2.40	-0.07	0.02	-0.10
1986	-0.40	-0.06	0.00	-0.32	-0.1	0.00	5.19	3.60	4.20	-0.11	-0.04	-0.10
1987	-0.28	-0.11	0.00	-0.40	-0.23	0.00	4.47	3.20	4.20	-0.10	-0.07	0.00
1988	-0.12	-0.13	0.00	-0.35	-0.36	0.10	4.09	3.00	4.50	-0.07	-0.10	0.00
1989	0.01	-0.12	0.00	-0.17	-0.46	0.10	3.83	2.80	4.50	-0.02	-0.10	0.00
1990	0.06	-0.07	0.00	0.08	-0.52	0.10	3.68	2.60	4.60	0.01	-0.09	0.00

SOURCE: For Taylor and Liverpool is Bryant (1988, Vol. 2), for MULTIMOD is IECAP.

a/ Instead of ROECD in Taylor and Liverpool, the results for Large Industrialized Countries are reported for MULTIMOD.

- The numbers for GNP, PGNP and ER are in percentage from the baseline and the number for RS are percentage point change from baseline.

GNP = Gross National Product
PGNP = GNP Price Deflator
ER = Exchange Rate
RS = Short-Term Interest Rate

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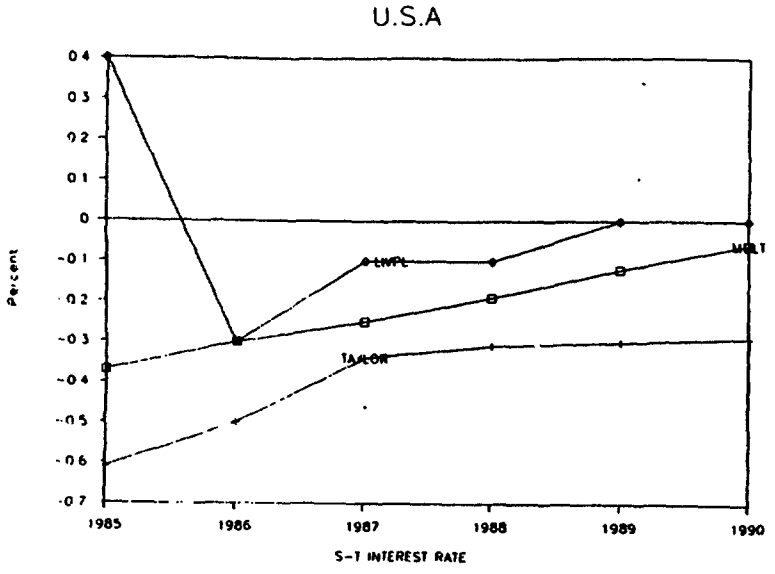
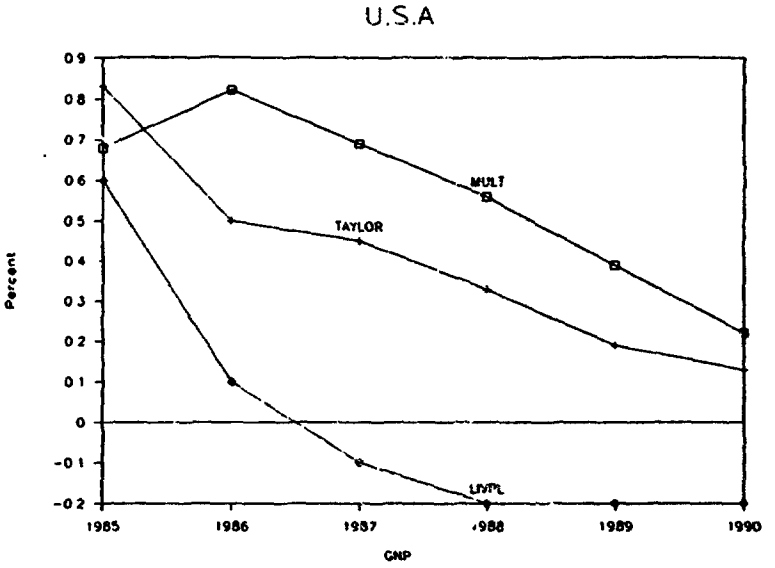
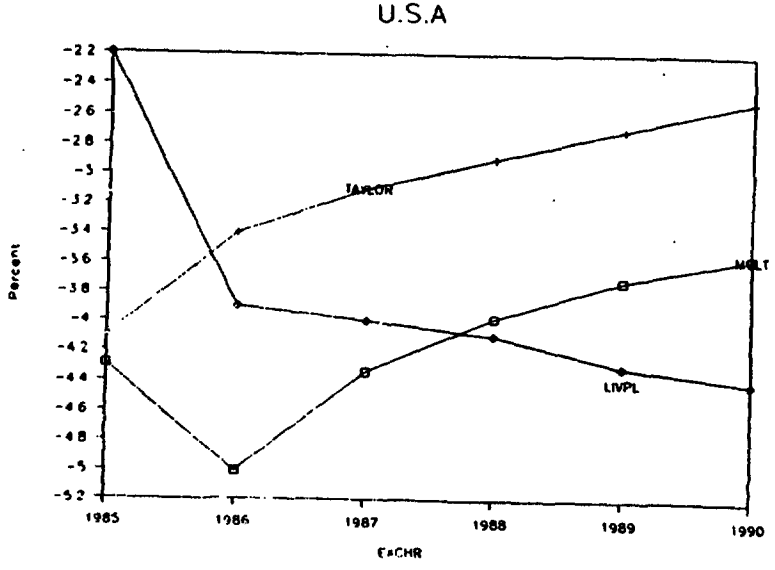
TAYLOR AND LIVERPOOL MODELS ON THE U.S. ECONOMY







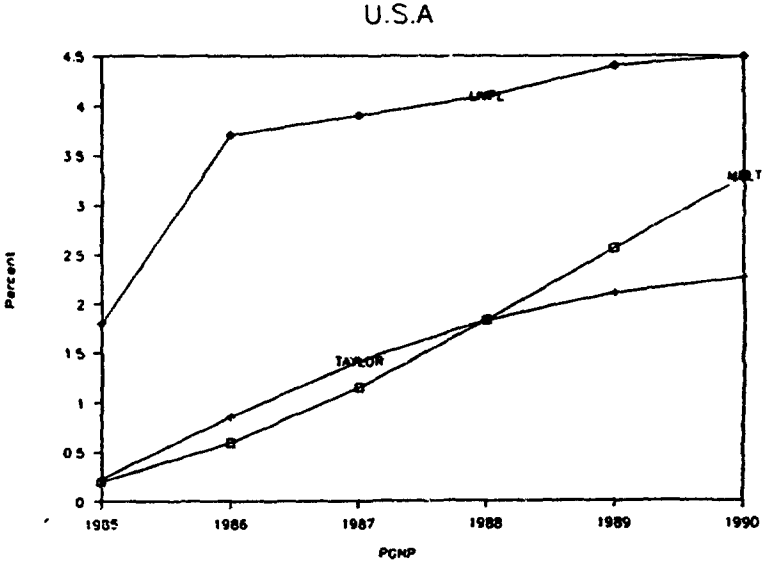
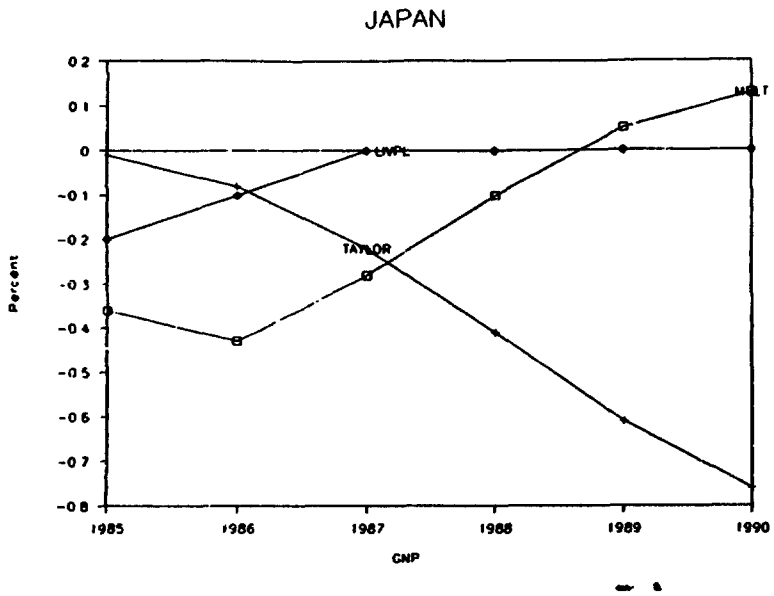
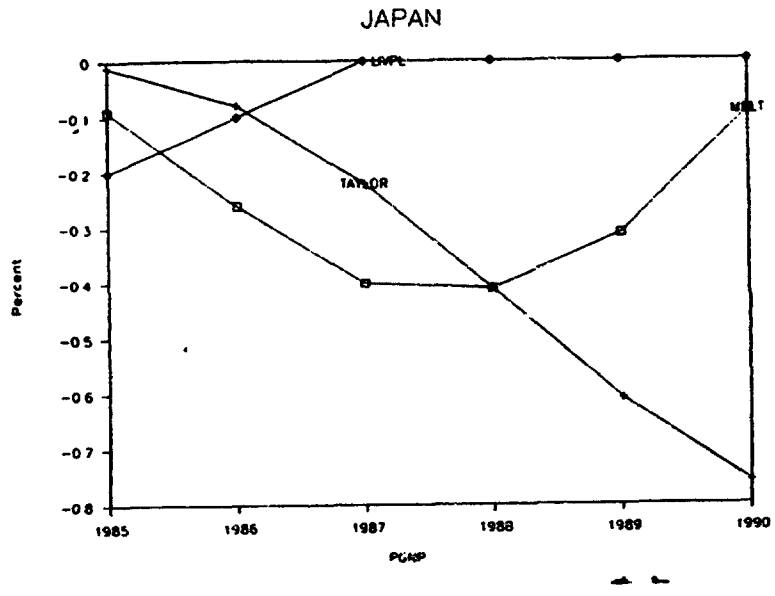
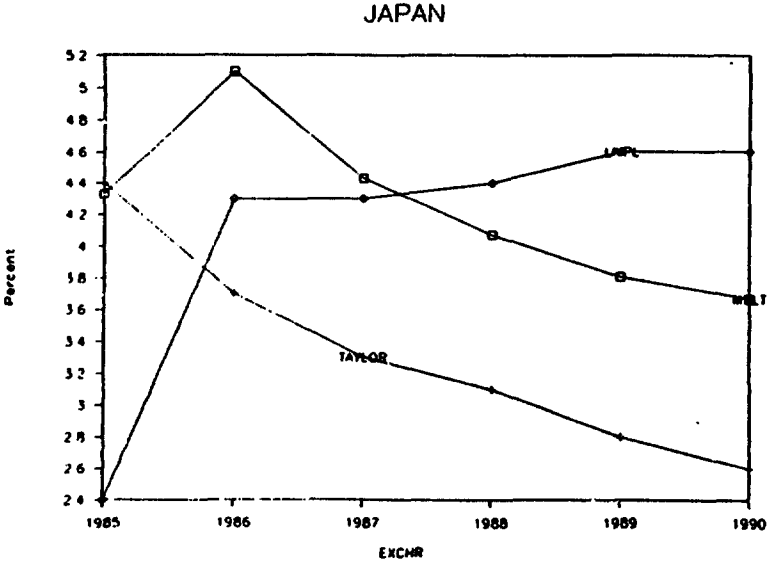


FIGURE 3

EFFECTS OF FOUR PERCENT INCREASE IN THE U.S. MONEY SUPPLY IN MULTIMOD, TAYLOR AND LIVERPOOL MODELS ON THE JAPANESE ECONOMY







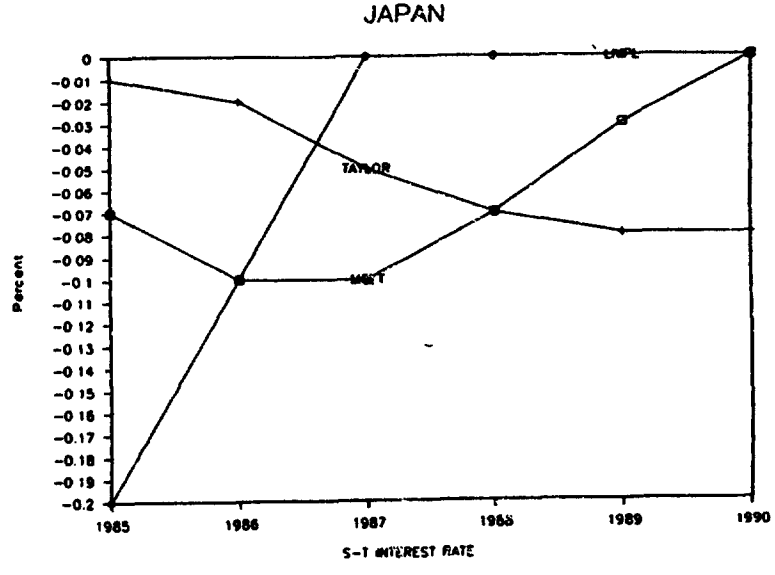
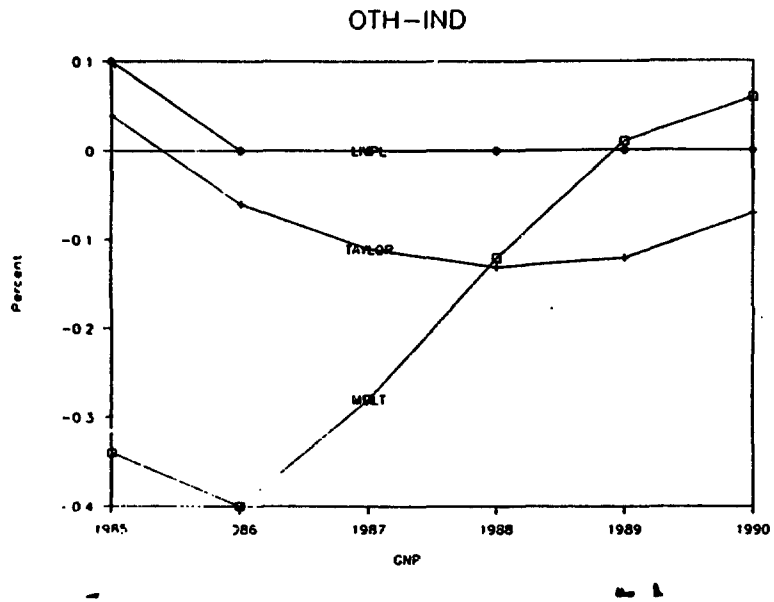
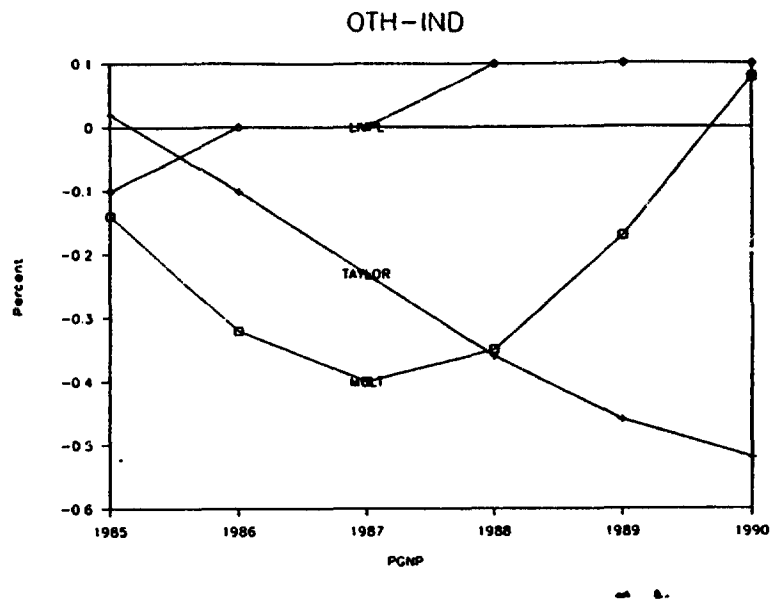
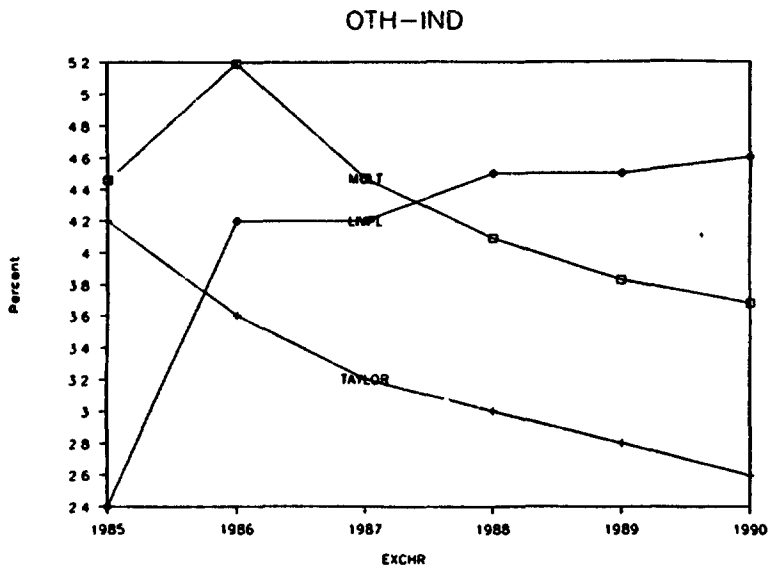


FIGURE 4

OF IN U.S. ON IN
(TAYLOR, LIVERPOOL) AND ON LARGE INDUSTRIALIZED COUNTRIES IN MULTIMOD







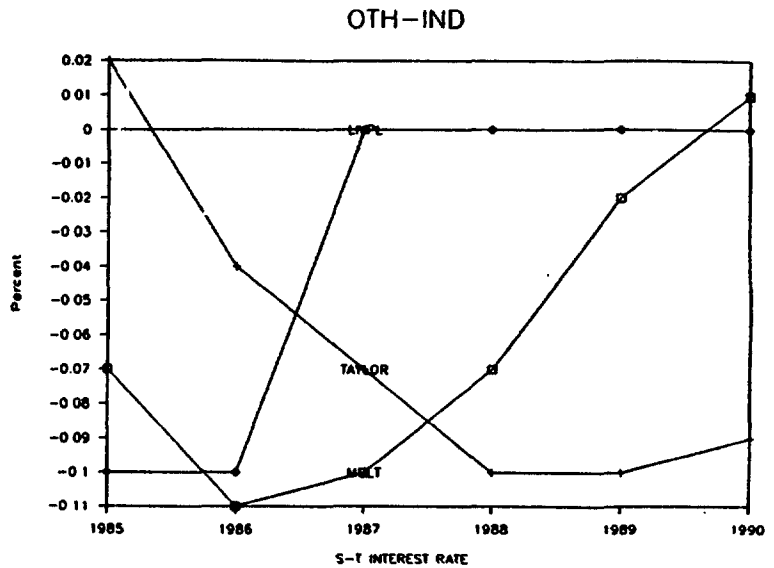


FIGURE 5

two models. Conversely, inflation rates in the non-originating blocks are smaller and more short-lived in the Liverpool model. This is because of the smaller spillover effects on output in the Liverpool model. Further, the impact of U.S. monetary expansion on its own output growth ismuch stronger, and lasts longer, in Taylor's model and in MULTIMOD. In the Liverpool model it lasts only for the first two simulation periods. The output growth reaches its peak in the second period in MULTIMOD while it does so on impact in the other two models. In the case of the Liverpool model there is strong tendency for the output to return to the baseline beyond the second period.

The comparative results owe their origin to major structural differences between the Liverpool model on the one hand and Taylor's model and MULTIMOD on the other. The Liverpool model is more "neo-classical" in spirit than the other two in that it uses rational expectations more extensively. Supply is very inelastic in the short-run and prices quickly clear the market. Thus the price movements are sharper, and monetary policy is almost ineffective in inducing output growth. In addition, since real wealth is one of the determinants of consumption, high rates of inflation reduce aggregate demand.

C. Developing Countries in MULTIMOD

How do monetary and fiscal policy interactions between industrialized and developing countries work? How does an increase in the financial flows change economic activities in the developing countries and what are the feedback effects on the industrialized countries? And, what are the consequences for the developing countries of changes in primary commodity prices? These issues are of primary importance in North-South relationships. In the following, the responses of MULTIMOD in the analysis of these issues are evaluated and their relations to the theoretical specification of the DC region are discussed.

1. Reaction of the Developing Countries to Fiscal and Monetary Policies of IndustrializedCountries

The model does not specify monetary and financial instruments for the developing countries. Instead, the reactions and responses of the developing countries to policy changes are formed by

postulated reaction functions. This specification makes them the recipients of policy decisions made in the industrialized countries.

The tables in Appendix A show the responses of the developing country block (DC) to fiscal and monetary policy shocks originating from the industrialized country blocks. An examination of the responses indicates that the output and price responses are similar to those of the non-originating industrialized country blocks, with some differences. First, the DC output reaches its peak with a lag relative to non-originating industrialized country blocks. The delay in reaching the peak is because of the nature of the shock transmission mechanism of the model.[23]

Second, monetary shocks in the industrialized countries were weaker in influencing economic activity in the DC region, relative to fiscal shocks (Tables A5 through A8). This is because of the partially offsetting nature of different influences generated by a monetary expansion. Monetary expansions reduce interest rates, depreciate exchange rates, increase prices, and improve trade balances of the industrialized countries. Reduction of interest rates has a positive effect on the DC region because it lowers the interest payments on debt. However, depreciated currencies reduce the demand for the exports of the DC region.

2. Structure of Financial Linkages Between Developing Countries and Industrialized Countries

This part explores the structure of North-South financial linkages and the capital flows in the model. It is also concerned with the analysis of increased economic activity in the developing countries due to an increase in the flow of funds, and its feedback effects on the industrialized countries. The above issues are examined by means of two scenarios both of which deal with an increased flow of funds to the developing countries, but under different circumstances.

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[23]The transmission mechanism works as follows: A rise in aggregate demand in the industrialized countries increases demand for exports from the DC region enhancing the DC's export earnings and credit-worthiness. The new earnings are spent on imports of additional manufactured goods from the industrialized countries. In turn, these imports increase the stock of capital and production of output. The time needed for these interactions to take place delays the peak of the output growth in the DC block.

Scenario 1: In this scenario, the capital flows from the industrialized blocks to the DC region are increased by $20 billion each year from 1988 to 1992, relative to the baseline. The capital flows (grants) are assumed to be financed by increasing the budget deficits in the industrialized country blocks, according to their respective GNP shares. The simulation results are presented in Table 9. Initially, the rise in the demand for imports from the industrialized blocks exerts an upward pressure on their domestic prices and interest rates. Both of these changes have a negative consequence for the DC region. Higher prices increase the cost of imports for the DC region while higher interest rates increase the interest payments. Overall, the increased capital inflow to the DC region stimulates output growth in both industrialized and developing countries, the growth rate differentials being higher for the industrialized countries. The growth rate of absorption (A), however is larger for the DC block than for the industrialized country blocks (Table 10). This is due to the method MULTIMOD uses to determine the components of absorption (consumption, C and investment, I) for the DC region. Investment (I) is determined residually as the difference between GDP and the sum of total (private and public) consumption (C), and net exports, (X - M).

$$I = GDP - C - X + M \qquad (3)$$

Consumption depends on a measure of disposable income that includes the real flow of available finances.

Any increase in the financial flows to the DC region first increases domestic absorption, directly, by increasing total consumption and, indirectly, through rising imports and investment. From equation (3) it is easy to see that the change in absorption is equal to the sum of changes in GDP and in net imports.[24]

$$\Delta A = \Delta GDP + \Delta(X - M) \qquad (4)$$

Hence, the growth rate of the domestic absorption is always higher than the output growth.

---

[24]Because of the low elasticities of demand for imports from the DC block, the deviation of DC exports from the baseline, compared to imports, is very small.

Table 9

THE EFFECTS OF A FIVE YEAR SUSTAINED ANNUAL INCREASE OF $20 BILLION IN THE FINANCIAL FLOWS TO DEVELOPING COUNTRIES

PERIODS	United States					Germany					Japan					Other Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ND
1988	0.27	0.08	-0.22	0.05	-3.05	0.43	0.20	0.24	0.09	0.23	0.43	0.21	0.19	0.09	2.19	0.43	0.28	0.23	0.09	0.11	0.02	0.24	0.27
1989	0.33	0.26	-0.15	0.08	-3.69	0.49	0.58	0.18	0.14	0.25	0.49	0.57	0.12	0.14	2.44	0.50	0.72	0.16	0.16	-0.46	0.05	0.57	1.26
1990	0.31	0.52	-0.05	0.11	-4.42	0.41	1.00	0.09	0.18	0.68	0.42	0.95	0.02	0.18	2.86	0.38	1.13	0.06	0.20	-1.25	0.05	0.91	1.93
1991	0.23	0.82	0.06	0.14	-5.58	0.28	1.34	-0.02	0.21	1.11	0.30	1.24	-0.09	0.20	3.13	0.22	1.39	-0.05	0.21	-1.96	0.04	1.16	2.47
1992	0.11	1.09	0.17	0.16	-6.99	0.14	1.48	-0.13	0.20	1.42	0.20	1.33	-0.19	0.20	3.31	0.13	1.41	-0.15	0.20	-2.23	0.03	1.24	2.67
1993	-0.18	1.29	0.26	0.13	-5.46	-0.27	1.42	-0.23	0.13	1.53	-0.18	1.23	-0.27	0.13	1.55	-0.25	1.22	-0.23	0.12	-2.61	0	1.12	1.76

GDP = Gross Domestic Product
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
ND = Net Debt

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

Table 10

EFFECTS OF FIVE YEAR SUSTAINED INCREASE IN FINANCIAL FLOWS
ON OUTPUT AND DOMESTIC ABSORPTION
OF THE INDUSTRIALIZED AND DEVELOPING COUNTRIES

	U.S.		GERMANY		JAPAN		Large Indust. Countries(LI)		Developing Countries	
PERIODS	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1988	.27	0.11	.43	0.22	.43	0.20	.43	0.21	.02	0.75
1989	.33	0.16	.49	0.34	.49	0.30	.50	0.33	.05	0.66
1990	.31	0.15	.41	0.29	.42	0.26	.38	0.24	.05	0.58
1991	.23	0.11	.28	0.17	.30	0.17	.22	0.11	.04	0.49
1992	.11	0.05	.14	0.05	.20	0.09	.13	0.02	.03	0.42

*Column (1) shows the growth rates of real GNP, and
Column (2) shows the absorption growth rates.
*Column (1) is repeated from Table 9.
*Column (1) for DC region are real GDP growth rates.

Scenario 2: This scenario deals with a debt reduction scheme carried out by reducing the DC stock of debt by $160 billion at the beginning of the simulation period.[25] This reduction is implemented in the model irrespective of the method of its financing.[26] By assumption, the critical level of the "debt interest payments to exports" ratio, which is the "measure" of the ability of developing countries to service debt in MULTIMOD, remains unchanged at 3 percent for the entire simulation period.[27]

Initially, the reduction in the stock of debt entails a decline in the net wealth of the private sector in the creditor countries. But, because of the increase in exports of these countries, they enjoy a rebound in economic activity: real GNP increases, current account improves, and the initial loss in private net wealth is more than offset in the long-run.

In addition, lower debt enables the developing countries to save on their interest payments. Lower interest payments improves the "measure" of their debt servicing ability or qualifies them for more borrowing, which, net of interest payments, is used to finance additional imports. Higher imports stimulate higher production in the industrialized countries (e.g., real GNP in the U.S. increases by 0.23 percent on impact). But the rise in output in the industrialized countries does not lead either to a significant increase in the demand for the developing countries' exports or to higher commodity prices. As a result, the developing countries face widening current account deficits

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[25] $160 billion is equivalent to a quarter of outstanding total external debt, both short-term and long-term, of all developing countries to the private creditors in 1987. Source: World Debt Tables, 1988-89 edition.

[26] However, according to some analysts, a reduction in outstanding debt to private creditors by $160 billion would bring it close to its true market value.

[27] "Flows of financing between industrial and developing countries in MULTIMOD are assumed to depend on the ability of developing countries to service their debt. The measure of servicing ability used is the ratio of debt interest payments, corrected for inflation, to exports. Expectations are assumed to be formed for that ratio: if it exceeds a threshold level imposed on the model, then additional financing will not be demanded or supplied. If it is less than the threshold, then financing will be available in an amount that depends on the difference between the expected level and the threshold level."

which have to be financed by new loans. This situation leads to a build-up in the stock of debt, gradually converging towards the baseline, and a small growth of GDP.

The simulation results in Table 11 indicate another important aspect: The increased capital flow raised the gross domestic investment significantly (3.52 percent higher in the first year than the baseline) made possible by a surge in imports (4.5 percent higher in the first year). This, in turn, led to higher capital accumulation and greater production capacity (the latter increased by an annual average of 5 percent (not shown in the Tables).

In the light of the above some, points are of significance to note:

- o the model places too much reliance on the assumption that developing countries spend their new resources on imports rather than on debt service;
- o new lending is excessively dependent upon the assessment of interest payments to export ratio, thus introducing a possible upward in the estimate of capacity-creating investment in the developing countries;[28] and
- o in view of the current losses suffered by the banks, the model needs to incorporate the issue that reduction in developing countries' debt has reduced the desirability of lending to these countries.

Thus, alternative criteria for new loans to the developing countries, and alternative specifications for developing country imports are important directions for future research.

3. Oil and Commodity Prices

In MULTIMOD, neither the oil market nor the commodity market has any stockholding demand or supply. There is no cushion to protect prices from large fluctuations. In the commodity market, supply has zero elasticity in the short run and any rise in demand forces prices to soar. It is only in the long run that supply increases and prices stabilize.

In contrast to the commodity market of the model, the excess demand for oil is met by a perfectly elastic supply in the short run.[29] The real price of oil is exogenous, but the nominal price

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[28]The model is very sensetive to the value of the "interest payments to exports" ratio of the developing countries block.

[29]In the wake of current existing capacity this is a viable assumption.

TABLE 11
$160 BILLION REDUCTION IN THE STOCK OF DEVELOPING COUNTRIES DEBT

PERCENTAGE DEVIATION FROM THE BASELINE UNLESS OTHERWISE NOTED

	1989	1990	1991	1992	1993	1994	1996	1998
UNITED STATES								
REAL GNP	0.23	0.32	0.31	0.23	0.11	-0.03	-0.28	-0.46
REAL DOMESTIC DEMAND	0.08	0.16	0.15	0.11	0.04	-0.03	-0.15	-0.24
GNP DEFLATOR 1/	0.1	0.22	0.32	0.37	0.38	0.33	0.14	-0.11
SH TERM INTEREST RATE,NOMINAL 2/	0.06	0.1	0.13	0.17	0.19	0.21	0.22	0.18
EFFECTIVE EXCHANGE RATE	-0.36	-0.31	-0.22	-0.1	0.02	0.12	0.24	0.23
TOTAL IMPORTS,VOLUME	-0.31	-0.29	-0.3	-0.28	-0.19	-0.05	0.26	0.42
TOTAL EXPORTS, VOLUME	1.65	1.7	1.58	1.29	0.9	0.49	-0.21	-0.65
TRADE BALANCE, VALUE 3/	6.06	6.	5.71	4.82	3.43	1.77	-1.63	-4.
CURRENT ACCOUNT BALANCE 3/	1.93	1.6	1.13	-0.02	-1.71	-3.79	-8.37	-12.11
TOTAL REAL NET PRIVATE WEALTH 4/	-31.81	-18.13	-0.56	15.38	27.63	33.25	20.	-23.81
GOV. FINANCIAL BALANCE 4/	-1.09	-1.3	-0.58	0.91	2.54	4.31	6.36	3.78
GERMANY:								
REAL GNP	0.39	0.49	0.4	0.21	0.01	-0.14	-0.23	-0.18
REAL DOMESTIC DEMAND	0.22	0.36	0.3	0.15	-0.02	-0.15	-0.25	-0.22
GNP DEFLATOR 1/	0.25	0.45	0.52	0.47	0.32	0.12	-0.22	-0.38
SH TERM INTEREST RATE,NOMINAL 2/	0.09	0.16	0.21	0.24	0.25	0.25	0.2	0.12
EXCHANGE RATE	0.37	0.33	0.25	0.15	0.04	-0.07	-0.21	-0.23
TOTAL IMPORTS, VOLUME	0.14	0.35	0.38	0.32	0.21	0.1	-0.05	-0.17
TOTAL EXPORTS, VOLUME	0.93	0.97	0.86	0.65	0.39	0.17	-0.09	-0.2
TRADE BALANCE, VALUE 3/	4.57	4.66	5.23	5.55	5.44	5.07	3.48	1.47
CURRENT ACCOUNT BALANCE ($US) 3/	1.87	2.11	2.72	3.23	3.46	3.53	3.13	2.29
TOTAL REAL NET PRIVATE WEALTH 4/	-13.06	-2.75	6.38	12.19	13.25	11.44	3.69	-4.81
GOV. FINANCIAL BALANCE 4/	-1.98	-3.	-3.11	-2.61	-1.57	-0.56	0.07	-1.77
JAPAN:								
REAL GNP	0.42	0.52	0.43	0.25	0.07	-0.06	-0.13	-0.08
REAL DOMESTIC DEMAND	0.2	0.33	0.28	0.16	0.02	-0.09	-0.16	-0.13
GNP DEFLATOR 1/	0.25	0.43	0.48	0.41	0.26	0.07	-0.21	-0.31
SH TERM INTEREST RATE,NOMINAL 2/	0.1	0.17	0.21	0.24	0.25	0.24	0.19	0.12
EXCHANGE RATE	0.35	0.29	0.19	0.08	-0.04	-0.13	-0.24	-0.21
TOTAL IMPORTS, VOLUME	0.18	0.31	0.36	0.39	0.38	0.33	0.17	-0.01
TOTAL EXPORTS, VOLUME	1.74	1.62	1.34	1.	0.68	0.44	0.17	0.01
TRADE BALANCE, VALUE 3/	0.74	0.77	0.75	0.68	0.57	0.45	0.23	0.06
CURRENT ACCOUNT BALANCE ($US) 3/	4.79	5.5	6.03	6.13	5.75	5.31	4.47	3.68
TOTAL REAL NET PRIVATE WEALTH 4/	-1.39	0.83	3.1	4.55	4.75	4.11	1.95	0.42
GOV. FINANCIAL BALANCE 4/	-0.34	-0.53	-0.62	-0.64	-0.54	-0.41	-0.25	-0.32

1/ INFLATION DIFFERENCE FROM THE BASELINE.
2/ BASIS POINTS DIFFERENCE FROM BASELINE. ONE FULL PERCENTAGE POINT IS EQUIVALENT TO 100.
3/ DIFFERENCE FROM THE BASELINE
4/ LEVEL DEVIATION FROM THE BASELINE IN BILLIONS OF LOCAL CURRENCY. A NEGATIVE NUMBER MEANS AN IMPROVEMENT IN THE BUDGET DEFICIT.

TABLE 11 CONTINUED
$160 BILLION REDUCTION IN THE STOCK OF DEVELOPING COUNTRIES DEBT

PERCENTAGE DEVIATION FROM THE BASELINE UNLESS OTHERWISE NOTED

	1989	1990	1991	1992	1993	1994	1996	1998
DEVELOPING COUNTRIES:								
REAL GDP	0.23	0.41	0.51	0.55	0.54	0.52	0.43	0.32
REAL DOMESTIC ABSORPTION	1.12	1.22	1.2	1.1	0.97	0.84	0.6	0.4
REAL GROSS INVESTMENT	3.52	2.27	1.13	0.16	-0.55	-1.	-1.33	-1.27
GNP DEFLATOR 1/	0.28	0.4	0.43	0.36	0.23	0.09	-0.14	-0.26
TL CON. EXP. INCL. PUBLIC	0.55	0.97	1.21	1.32	1.33	1.27	1.06	0.79
STOCK OF DEBT	-10.58	-8.01	-5.85	-4.07	-2.65	-1.55	-0.13	0.49
STOCK OF NET DEBT	-12.02	-10.05	-8.2	-6.55	-5.11	-3.9	-2.1	-0.96
NET FOREIGN ASSETS 3/	145.	128.96	111.96	95.06	78.9	64.02	38.91	20.02
VOLUME OF TOTAL IMPORTS	4.5	4.15	3.55	2.83	2.16	1.61	0.86	0.39
VOLUME OF TOTAL EXPORTS	0.16	0.25	0.25	0.2	0.14	0.1	0.06	0.
TRADE BALANCE, VALUE 3.5/	-26.37	-26.52	-26.05	-24.39	-22.15	-19.47	-14.08	-9.41
NET INTEREST PYMT 3.6/	-11.36	-10.46	-9.05	-7.48	-5.99	-4.61	-2.34	-0.77
CURRENT ACCOUNT BALANCE 3/	-15.	-16.04	-16.99	-16.9	-16.16	-14.88	-11.78	-8.68
PRINCIPAL RATIOS:								
NET INTEREST PYMT/EXPORTS:								
BASELINE	-8.07	-7.96	-7.56	-7.14	-6.74	-6.38	-5.83	-5.39
SCENARIO	-6.22	-6.35	-6.24	-6.09	-5.93	-5.77	-5.52	-5.27
DIFFERENCE	1.85	1.61	1.32	1.05	0.81	0.61	0.31	0.12
TOTAL DEBT/EXPORTS:								
BASELINE	199.39	195.81	192.27	188.77	185.32	181.93	175.27	168.82
SCENARIO	177.31	178.27	178.5	178.06	177.11	175.72	172.04	167.63
DIFFERENCE	-22.09	-17.54	-13.77	-10.71	-8.21	-6.21	-3.23	-1.19
TOTAL DEBT/GDP:								
BASELINE	38.42	38.93	39.44	39.96	40.48	41.	42.06	43.13
SCENARIO	34.28	35.66	36.95	38.12	39.19	40.16	41.82	43.2
DIFFERENCE	-4.14	-3.26	-2.49	-1.84	-1.29	-0.84	-0.24	0.07
INTERNATIONAL PRICES 7/:								
PRICE OF OIL IN DOLLARS	0.46	0.81	1.19	1.5	1.7	1.77	1.62	1.21
PRICE INDEX OF COMM	1.74	1.91	1.67	1.39	1.2	1.13	0.99	0.62

1/ INFLATION DIFFERENCE FROM THE BASELINE.
3/ DIFFERENCE FROM THE BASELINE.
5/ NEGATIVE NUMBERS ARE DEFICIT AND POSITIVE NUMBERS ARE SURPLUS, IN BILLIONS OF US DOLLARS.
6/ NEGATIVE NUMBERS ARE REDUCTION AND POSITIVE NUMBERS ARE INCREASE IN INTEREST PAYMENTS, IN BILLIONS OF US DOLLARS.
7/ DENOMINATED INDICES IN TERMS OF US DOLLARS, 1980=1.

is determind, in the long run, by adjusting the real price by a weighted average of GNP deflators of the industrialized countries. Thus, oil prices may be expected to fluctuate less than commodity prices. This was confirmed by the results of the simulations performed in the Appendix (not shown): the percentage deviation of commodity prices stayed higher than those of the oil prices, in the first two or three periods of the simulation, but the two converged towards the end of the simulation.

Table 12 summarizes the effects of a 20 percent sustained increase in the nominal price of oil. These results suggest that an increase in the price of oil leads to higher import prices in the industrialized countries. Consequently, their relative prices (ratio of import prices to domestic prices) increase, oil imports fall, the costs of production increase, the domestic inflation rates rise, and ouputs decline in the early periods (stagflation). The interest rate differentials change and the US dollar appreciates against all other currencies, which has a favorable impact on exports from Japan and the European countries. In the long run, ascending domestic prices gradually lower the relative prices toward their baseline positions. For the high income oil exporters (HO) and developing countries (DC), higher oil prices and lower activity in the industrialized countries limit their exports (basically oil), restrain their GDP growth rates, but improve their capacity to increase imports. The rise in imports of HO and DC regions stimulates exports from --and economic activity in --the industrialized countries, partially offseting the initial slowdown. Thus, oil price increases are stagflationary in the short run in the industrialied countries, and their adjustment takes place in the long run.

In addition to higher imports, HO and DC regions increase their domestic absorption and improve their foreign reserves, as a result of higher oil prices. It is conceivable that their accumulation of foreign reserves increases the supply of loanable funds available to other developing countries in the international monetary system, lowers the interest rates applied to their debts, and reduces their debt service ratio. Incorporation of these interactions will increase the usefulness of the model in analysing key North-South issues.

Table 12

THE IMPACT OF 20 PERCENT SUSTAINED INCREASE IN OIL PRICES

PERCENTAGE DEVIATION FROM THE BASELINE UNLESS OTHERWISE NOTED

	1988	1989	1990	1991	1992	1993
UNITED STATES						
REAL GNP	-0.24	-0.2	-0.07	0.05	0.14	0.18
REAL DOMESTIC DEMAND	-0.26	-0.27	-0.18	-0.09	-0.03	0.
GNP DEFLATOR 1/	0.24	-0.03	-0.01	0.05	0.14	0.23
SH TERM INTEREST RATE,NOMINAL 2/	0.02	0.02	0.05	0.07	0.1	0.14
EFFECTIVE EXCHANGE RATE	0.72	0.78	0.85	0.95	1.06	1.19
TOTAL IMPORTS,VOLUME	-0.33	-0.73	-1.01	-1.26	-1.48	-1.67
TOTAL EXPORTS, VOLUME	-0.12	-0.08	0.	0.07	0.1	0.07
TRADE BALANCE, VALUE 3/	-5.3	-4.77	-4.34	-3.98	-3.67	-3.51
TERMS OF TRADE	-1.22	-1.48	-1.7	-1.89	-2.04	-2.13
CURRENT ACCOUNT BALANCE 3/	-5.3	-5.41	-5.78	-6.44	-7.03	-7.84
TOTAL REAL NET PRIVATE WEALTH 4/	-37.5	-55.69	-70.31	-79.81	-80.13	-75.31
GOV. FINANCIAL BALANCE 4/	3.89	4.94	5.23	5.7	5.99	6.6
GERMANY:						
REAL GNP	-0.08	-0.07	0.01	0.08	0.1	0.08
REAL DOMESTIC DEMAND	-0.23	-0.23	-0.16	-0.08	-0.05	-0.05
GNP DEFLATOR 1/	0.09	0.15	0.22	0.3	0.36	0.39
SH TERM INTEREST RATE,NOMINAL 2/	0.04	0.06	0.1	0.15	0.2	0.24
EXCHANGE RATE	-0.63	-0.69	-0.75	-0.84	-0.94	-1.05
TOTAL IMPORTS, VOLUME	-0.43	-0.52	-0.49	-0.44	-0.39	-0.38
TOTAL EXPORTS, VOLUME	0.01	-0.03	0.02	0.05	0.05	0.02
TRADE BALANCE, VALUE 3/	-2.59	-2.67	-2.48	-2.29	-2.05	-1.78
TERMS OF TRADE	-0.93	-0.97	-0.97	-0.93	-0.86	-0.78
CURRENT ACCOUNT BALANCE (SUS) 3/	-1.96	-2.1	-2.06	-1.94	-1.83	-1.64
TOTAL REAL NET PRIVATE WEALTH 4/	-37.25	-42 75	-46.63	-48.38	-50.56	-53.06
GOV. FINANCIAL BALANCE 4/	1.67	1.91	1.69	1.43	1.21	1.34
JAPAN:						
REAL GNP	-0.11	-0.06	0.01	0.06	0.09	0.01
REAL DOMESTIC DEMAND	-0.23	-0.21	-0.15	-0.1	-0.09	-0.11
GNP DEFLATOR 1/	0.09	0.17	0.26	0.33	0.37	0.38
SH TERM INTEREST RATE,NOMINAL 2/	0.03	0.06	0.11	0.16	0.2	0.25
EXCHANGE RATE	-0.72	-0.78	-0.84	-0.93	-1.03	-1.14
TOTAL IMPORTS, VOLUME	-0.39	-0.59	-0.68	-0.72	-0.74	-0.76
TOTAL EXPORTS, VOLUME	0.3	0.29	0.26	0.2	0.11	0.01
TRADE BALANCE, VALUE 3/	-0.5	-0.43	-0.41	-0.4	-0.4	-0.43
TERMS OF TRADE	-2.3	-2.22	-2.17	-2.09	-1.98	-1.91
CURRENT ACCOUNT BALANCE (SUS) 3/	-4.58	-4.29	-4.22	-4.16	-4.32	-4.59
TOTAL REAL NET PRIVATE WEALTH 4/	-6.63	-7.74	-8.77	-9.44	-10.48	-11.52
GOV. FINANCIAL BALANCE 4/	0.18	0.16	0.08	-0.	-0.1	-0.12
OTHER LARGE INDUSTRIAL COUNTRIES:						
REAL GNP	-0.19	-0.18	-0.08	0.01	0.03	0.
REAL DOMESTIC DEMAND	-0.25	-0.26	-0.17	-0.08	-0.05	-0.06
GNP DEFLATOR 1/	0.31	0.16	0.24	0.32	0.37	0.38
SH TERM INTEREST RATE,NOMINAL 2/	0.03	0.05	0.1	0.15	0.2	0.24
EXCHANGE RATE	-0.52	-0.56	-0.62	-0.7	-0.8	-0.91
TOTAL IMPORTS, VOLUME	-0.2	-0.33	-0.37	-0.38	-0.38	-0.39
TOTAL EXPORTS, VOLUME	0.02	-0.01	0.01	0.01	-0.03	-0.08
TRADE BALANCE, VALUE 3/	-1.8	-1.81	-1.35	-1.36	-1.82	-2.55
TERMS OF TRADE	-0.39	-0.46	-0.46	-0.44	-0.42	-0.41
CURRENT ACCOUNT BALANCE (SUS) 3/	-1.27	-1.34	-1.09	-1.24	-1.73	-2.48
TOTAL REAL NET PRIVATE WEALTH 4/	-22.07	-30.42	-32.16	-31.31	-31.06	-33.
GOV. FINANCIAL BALANCE 4/	2.26	3.27	3.58	4.2	4.94	6.36

1/ INFLATION DIFFERENCE FROM THE BASELINE.
2/ BASIS POINTS DIFFERENCE FROM BASELINE. ONE FULL PERCENTAGE POINT IS EQUIVALENT TO 100.
3/ DIFFERENCE FROM THE BASELINE.
4/ LEVEL DEVIATION FROM THE BASELINE IN BILLIONS OF LOCAL CURRENCY. A NEGATIVE NUMBER MEANS AN IMPROVEMENT IN THE BUDGET DEFICIT.

Table 12

THE IMPACT OF 20 PERCENT SUSTAINED INCREASE IN OIL PRICES

PERCENTAGE DEVIATION FROM THE BASELINE UNLESS OTHERWISE NOTED

	1988	1989	1990	1991	1992	1993
SMALL INDUSTRIAL COUNTRIES:						
REAL GNP	0.01	0.15	0.13	0.11	0.07	0.06
REAL DOMESTIC DEMAND	-0.2	-0.08	-0.04	-0.02	-0.04	-0.05
GNP DEFLATOR 1/	0.15	0.28	0.37	0.41	0.39	0.36
SH TERM INTEREST RATE,NOMINAL 2/	0.06	0.11	0.15	0.19	0.23	0.27
EXCHANGE RATE	-1.11	-1.21	-1.33	-1.47	-1.62	-1.77
TOTAL IMPORTS, VOLUME	-0.26	-0.34	-0.23	-0.12	-0.08	-0.06
TOTAL EXPORTS, VOLUME	0.22	0.19	0.17	0.18	0.19	0.21
TRADE BALANCE, VALUE 3/	-1.55	-0.4	-1.08	-1.74	-1.8	-1.57
TERMS OF TRADE	-0.55	-0.46	-0.39	-0.32	-0.28	-0.24
CURRENT ACCOUNT BALANCE (SUS) 3/	-0.49	0.45	-0.02	-0.53	-0.65	-0.62
TOTAL REAL NET PRIVATE WEALTH 4/	-13.11	-7.43	-5.07	-3.65	-2.42	-0.98
GOV. FINANCIAL BALANCE 4/	1.51	1.59	2.68	4.1	5.38	6.43
DEVELOPING COUNTRIES:						
REAL GDP	-0.08	-0.14	-0.18	-0.22	-0.25	-0.28
REAL DOMESTIC ABSORPTION	0.12	0.12	0.08	0.03	-0.02	-0.07
REAL GROSS INVESTMENT	0.68	0.78	0.78	0.74	0.69	0.63
GNP DEFLATOR 1/	0.48	0.14	0.2	0.27	0.31	0.33
TL CON. EXP. INCL. PUBLIC	-0.01	-0.04	-0.08	-0.13	-0.19	-0.24
STOCK OF DEBT	0.09	0.27	0.44	0.61	0.78	0.97
STOCK OF NET DEBT	-0.2	-0.25	-0.24	-0.21	-0.18	-0.14
NET FOREIGN ASSETS 3/	2.3	2.96	3.07	2.92	2.6	2.12
VOLUME OF TOTAL IMPORTS	0.62	0.67	0.59	0.44	0.28	0.12
VOLUME OF TOTAL EXPORTS	-0.34	-0.56	-0.66	-0.72	-0.79	-0.85
TRADE BALANCE, VALUE 3,5/	2.52	1.06	0.86	1.08	1.17	1.29
TERMS OF TRADE	1.33	1.33	1.3	1.24	1.13	1.02
NET INTEREST PYMT 3,6/	0.	0.18	0.51	0.96	1.19	1.46
CURRENT ACCOUNT BALANCE 3/	2.3	0.66	0.11	-0.15	-0.32	-0.48
HIGH INCOME OIL PRODUCERS:						
REAL GDP	-0.53	-0.93	-1.28	-1.62	-1.99	-2.36
REAL DOMESTIC ABSORPTION	0.22	0.31	0.31	0.23	0.05	-0.19
NET FOREIGN ASSETS 3/	11.11	22.68	34.91	48.02	62.13	77.5
VOLUME OF TOTAL IMPORTS	0.48	0.68	0.69	0.5	0.12	-0.43
VOLUME OF TOTAL EXPORTS	-1.45	-2.5	-3.39	-4.21	-5.03	-5.83
TRADE BALANCE, VALUE 3,5/	11.01	10.51	10.08	9.82	9.75	9.93
TERMS OF TRADE	16.45	16.67	16.6	16.47	16.3	16.13
CURRENT ACCOUNT BALANCE 3/	11.11	11.57	12.23	13.11	14.1	15.38
INTERNATIONAL PRICES 7/:						
PRICE OF OIL IN DOLLARS	20.	20.	20.	20.	20.	20.
PRICE INDEX OF COMMODITIES	-0.79	-0.59	-0.25	0.05	0.24	0.38

1/ INFLATION DIFFERENCE FROM THE BASELINE.
3/ DIFFERENCE FROM THE BASELINE.
5/ NEGATIVE NUMBERS ARE DEFICIT AND POSITIVE NUMBERS ARE SURPLUS, IN BILLIONS OF US DOLLARS.
6/ NEGATIVE NUMBERS ARE REDUCTION AND POSITIVE NUMBERS ARE INCREASE IN INTEREST PAYMENTS, IN BILLIONS OF US DOLLARS.
7/ DENOMINATED INDICES IN TERMS OF US DOLLARS, 1980=1.

IV. Validation of the Model: a Structural Sensitivity Analysis

In the last section, we carried out an evaluation of MULTIMOD by comparing its results with theoretical expectations and results of other macroeconometric models. We now turn to an assessment of its structural features. The broad aim of such a structural sensitivity analysis is to identify the crucial behavioral determinants of the model, that is, those exogenous variables and parameters which have a dominant influence on endogenous variables of interest. Since MULTIMOD is a moderately large model and structural sensitivity analysis is very computation-intensive, the analysis is carried through for selected variables and equations only. Thus the aim of this section is not to attempt a comprehensive validation of the model, but to give a flavor of the relatively recent techniques for analyzing macroeconometric models.[30] We start with an examination of the linearity and symmetry properties of the model, and go on to an investigation of its structural sensitivity homogeneous dynamic, elasticity-scaled multiplier, and parameter perturbation analyses.

A. Symmetry and Linearity Tests

1. Zellner-Peck Tests for Linearity and Symmetry

In order to study the linearity and symmetry of the model we employ a technique developed by Zellner and Peck.[31] According to them:

> "Symmetry is of interest for its own sake while a finding of linearity or near-linearity may be useful in efforts to simplify the model's structure."

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[30] In carrying out the structural sensitivity analysis we closely follow methods outlined by Kuh and others: Kuh and Neese (1982) and Kuh, Neese, and Hollinger (1985). See also "TROLL Program: LIMO (Linear Model Analysis) Technical Report No. 34."

[31] See Zellner and Peck (1973)

With a linear model we can calculate the characteristic roots and vectors, which provide important information. Linear models are also computationally less expensive. More importantly, in linear models multipliers would be the same whatever the initial values of the endogenous variables whereas in non-linear models the multipliers depend on the size of the variation of the particular exogenous variable as well as starting values of all the endogenous variables (Pindyck and Rubinfield, 1981 p. 393).

The Zellner-Peck linearity measure (denoted LIN) and symmetry measure, (denoted SYM) are averaged over a period of the extent to which the changes in model responses from the "base line", caused by perturbations, deviate from symmetry or linearity. First, the base run is obtained by running the model with historical data over a period T. Then the model is run successively with pre-selected changes in policy control vairables of interest. A deviation from the base run for a variable y in period t is defined by:

$$\delta y_{t,\Delta} = y_{t,\Delta} - y_{t,0} \tag{5}$$

where

$y_{t,0}$ = value of y in period t for the base run; and
$y_{t,\Delta}$ = value of y in period t with a policy control changed by Δ units.

The relative measure of model symmetry, SYM, is defined as:

$$\text{SYM}(\Delta, -\Delta) = \frac{\sum_{t=1}^{T} |\delta y_{t,\Delta} + \delta y_{t,-\Delta}|}{\frac{1}{2}\sum_{t=1}^{T} (|\delta y_{t,\Delta}| + |\delta y_{t,-\Delta}|)} \tag{6}$$

Note that if the response of y is symmetric, $\delta y_{t,-\Delta} = -\delta y_{t,\Delta}$, and thus a value of SYM close to zero implies that the model is highly symmetric in the response of variable y to the policy control chosen.

Similarly, the relative measure of linearity, LIN, is defined as:

$$\text{LIN}(k\Delta, \Delta) = \frac{\sum_{t=1}^{T} |\delta y_{t,k\Delta} - k\delta y_{t,\Delta}|}{\frac{1}{2}\sum_{t=1}^{T} (|\delta y_{t,k\Delta}| + |k\delta y_{t,-\Delta}|)} \tag{7}$$

where k is an amplification factor. For a given Δ, a small value of k would test local linearity and a large value, global linearity. If the model response is linear, $\delta y_{t,k\Delta} = k\delta y_{t,\Delta}$, and, hence, a value of LIN near zero indicates high degree of linearity.

2. Empirical Results of Symmetry and Linearity Tests

To test the symmetry and linearity of MULTIMOD two exogenous variables were chosen for perturbation: the German real government spending and the United States target level of the monetary base. The selection of Germany in the first case is to test the symmetry and linearity of the model with respect to perturbations in a smaller economy.

Perturbations introduced in the German government expenditures were ±1 and ±5 percent of GNP, and those in the U.S. monetary target base were ±1, ±5, and ±10 percent for seven periods.[32]

The SYM and LIN measures for both the perturbations are shown in Table 13. The SYM values are quite low indicating that the model is, in fact, highly symmetric. Treating a SYM value of 0.5 as the threshold for asymmetric behavior, only a few variables respond asymmetrically, most notably the implicit GNP price deflator (PGNP) for all the blocks except the United States. The PGNPs are symmetric when the perturbations have a magnitude of one percent, both for monetary and fiscal shocks. But they become asymmetric as the magnitude of the perturbation rises. This is more true for monetary than for government perturbation, presumably because the influence of a monetary stimulus on production capacity and prices is less direct than a fiscal stimulus. The asymmetric behavior of PGNP reflects the extent of price rigidity. Short-term interest rates and manufactures export deflators also show some asymmetric behavior. The former is just a by-product of the asymmetry of PGNP while the latter is due to its own downward rigidity. Figures 6 and 7 display the deviations of GNP and GNP deflators from the baseline for government and monetary perturbations.

Table 13 also presents the measures of linearity (LIN). It may be recalled that the higher the deviation of LIN from zero, the more nonlinear is the behavior of the variable. The LIN values obtained suggest that the behavior of the model is more linear in reaction to government than to

[32]The simulations of the model always converged faster for positive perturbations.

Table 13

ZELLNER-PECK SYMMETRY AND LINEARITY MEASURES FOR MULTIMOD

1. Perturbations of Germany's Real Government Expenditures

	US GNP	US A	US PGNP	US RL	US RS	US MERM	US GDEF	US INVEST	JA GNP	JA PGNP	JA RS	JA ER	JA PXM	JA CURBAL
SYM(+1,-1)	0.0097	0.0093	0.0132	0.0086	0.0061	0.0041	0.0354	0.0086	0.0047	0.0166	0.0062	0.0277	0.0161	0.0302
SYM(+5,-5)	0.2292	0.5879	0.1978	0.2545	0.1889	0.0448	0.2868	0.6236	0.3063	0.0757	0.1498	0.2016	0.0367	0.0898
LIN(+5,+1)	0.1436	0.1492	0.0001	0.0072	0.0019	0.0000	0.0489	0.0634	0.0133	0.0001	0.0017	0.0002	0.0001	0.0045
LIN(-5,-1)	0.3813	1.1093	0.3924	0.7677	0.3303	0.0689	1.0285	0.8299	0.3083	0.1656	0.1744	1.0286	0.0985	0.1079

2. Perturbations of the United States Target Monetary Base

	US GNP	US A	US PGNP	US RL	US RS	US MERM	US GDEF	US INVEST	JA GNP	JA PGNP	JA RS	JA ER	JA PXM	JA CURBAL
SYM(+1,-1)	0.0096	0.0286	0.0286	0.0112	0.0097	0.0091	0.0115	0.0372	0.0189	0.3516	0.0450	0.0083	0.0266	0.0369
SYM(+5,-5)	0.0494	0.0460	0.0248	0.0740	0.0498	0.0983	0.0506	0.0530	0.0430	0.1052	0.0557	0.0068	0.0773	0.0124
SYM(+10,-10)	0.0690	0.0146	0.0165	0.3165	0.1298	0.2314	0.0199	0.0369	0.2530	0.9548	0.4682	0.0403	0.5618	0.0099
LIN(10,1)	1.5485	1.7442	1.8107	0.8808	0.6063	1.5516	0.4313	1.5148	1.4992	1.6287	1.5730	1.5861	1.5883	1.8785
LIN(-10,-1)	1.5728	1.7419	1.8051	0.6310	0.4952	1.6332	0.4129	1.5258	1.6038	1.9010	1.7331	1.5978	1.7256	1.8824
LIN(+10,+5)	0.0161	0.0527	0.0184	0.2572	0.0452	0.0030	0.0735	0.0373	0.1181	0.1171	0.0948	0.0430	0.0541	0.0332
LIN(+5,+1)	1.5535	1.7563	1.8073	1.0770	0.5650	1.5528	0.4448	1.5305	1.4451	1.6022	1.5355	1.5698	1.5682	1.8745

* SYM is symmetry measure. A value of SYM near zero indicates high symmetry.
* LIN is linearity measure. A value of LIN near zero indicates perfect linearity.

Notation: US (United States), JA (Japan), GR (Germany), LI (Other G-7), SI (Small Industrialized Countries, DC (Developing Countries).
GNP (Gross National Product), PGNP (GNP deflator), RS (short term interest rate), RL (long term interest rate),
A (domestic absorption), MERM (weighted effective exchange rate), INVEST (gross investment), GDEF (nominal government deficit)
CURBAL (current account), PXM (mfg export prices), ER (exchange rate), IM (import volume), POIL (oil price), PCOM (Commodity price)

Table 13

...Perturbations of Germany's Real Government Expenditures

	GR GNP	GR PGNP	GR RS	GR ER	GR PXM	GR CURBAL	LI GNP	LI PGNP	LI RS	LI ER	LI PXM	LI CURBAL
SYM(+1,-1)	0.0088	0.0212	0.0050	0.0048	0.0216	0.0477	0.0157	0.0246	0.0082	0.0131	0.0208	0.0455
SYM(+5,-5)	0.0609	0.0806	0.0366	0.0471	0.0875	0.2331	1.0437	0.0435	0.1282	0.0598	0.0541	0.1979
LIN(+5,+1)	0.0953	0.0001	0.0028	0.0000	0.0001	0.0241	0.1118	0.0002	0.0027	0.0000	0.0002	0.0033
LIN(-5,-1)	0.2621	0.2141	0.2436	0.1200	0.2802	0.0767	0.6575	0.2921	0.3097	0.0828	0.2745	0.1017

...Perturbations of the United States Target Monetary Base

	GR GNP	GR PGNP	GR RS	GR ER	GR PXM	GR CURBAL	LI GNP	LI PGNP	LI RS	LI ER	LI PXM	LI CURBAL
SYM(+1,-1)	0.0308	0.2241	0.0628	0.0075	0.0372	0.0077	0.0827	0.1341	0.0748	0.0070	0.0349	0.0230
SYM(+5,-5)	0.0419	0.1756	0.0518	0.0059	0.0953	0.0045	0.0283	0.1544	0.0537	0.0057	0.0945	0.0595
SYM(+10,-10)	0.3253	1.5077	0.6781	0.0356	0.6645	0.0256	0.1956	0.9623	0.4073	0.0335	0.5857	0.0913
LIN(10,1)	1.5671	1.5395	1.5974	1.5908	1.6034	1.6441	1.8818	1.6582	1.7612	1.5785	1.4998	1.9566
LIN(-10,-1)	1.6620	1.9140	1.7937	1.6010	1.7650	1.6362	1.8970	1.8327	1.8413	1.5884	1.6572	1.9595
LIN(+10,+5)	0.1954	0.1154	0.1626	0.0475	0.0519	0.0470	0.1513	0.0926	0.1084	0.0462	0.0546	0.1971
LIN(+5,+1)	1.4427	1.4910	1.5458	1.5730	1.5845	1.6286	1.8639	1.6289	1.7357	1.5607	1.4760	1.9498

...Perturbations of Germany's Real Government Expenditures

	SI GNP	SI PGNP	SI RS	SI ER	SI PXM	SI CURBAL	NO GDP	DC GDP	DC PGNP	DC IM	PCOM	POIL
SYM(+1,-1)	0.0079	0.0243	0.0050	0.0181	0.0208	0.0652	0.0079	0.0697	0.0198	0.0279	0.0236	0.0184
SYM(+5,-5)	0.2874	0.0433	0.0846	0.0572	0.0451	0.3429	0.2572	0.1355	0.0406	0.1628	0.0488	0.0167
LIN(+5,+1)	0.0711	0.0002	0.0023	0.0000	0.0001	0.0105	0.0141	0.0446	0.0001	0.0343	0.0001	0.0001
LIN(-5,-1)	0.2394	0.2255	0.1957	0.0022	0.2262	0.1126	0.3639	1.2232	0.2602	0.5686	0.2147	0.1419

...Perturbations of the United States Target Monetary Base

	SI GNP	SI PGNP	SI RS	SI ER	SI PXM	SI CURBAL	NO GDP	DC GDP	DC PGNP	DC IM	PCOM	POIL
SYM(+1,-1)	0.0225	0.1494	0.0440	0.0075	0.0625	0.0390	0.0134	0.0223	0.0714	0.0091	0.0110	0.0112
SYM(+5,-5)	0.0650	0.1170	0.0395	0.0061	0.0937	0.0309	0.0863	0.1116	0.0487	0.0838	0.0080	0.0146
SYM(+10,-10)	0.1981	1.0797	0.4670	0.0226	0.4916	0.0886	0.1753	0.4978	0.7410	0.1142	0.0094	0.0320
LIN(10,1)	1.6270	1.6153	1.6390	1.5845	1.6091	1.7119	0.9033	1.7252	1.7366	0.6758	1.5659	1.6091
LIN(-10,-1)	1.6533	1.6972	1.7225	1.5901	1.6947	1.7241	0.9538	1.9066	1.7410	0.7674	1.5640	1.6147
LIN(+10,+5)	0.1957	0.2273	0.0650	0.0397	0.0656	0.0496	0.1549	0.2033	0.0619	0.0563	0.0310	0.0366
LIN(+5,+1)	1.4828	1.5624	1.6148	1.5695	1.6061	1.7015	1.0224	1.5905	1.7228	0.7252	1.5537	1.5960

FIGURE 6.1

GNP/GDP Deviations from the Base Run After (+/-) Five Percent Changes in the Germany's Real Government Expenditures in MULTIMOD

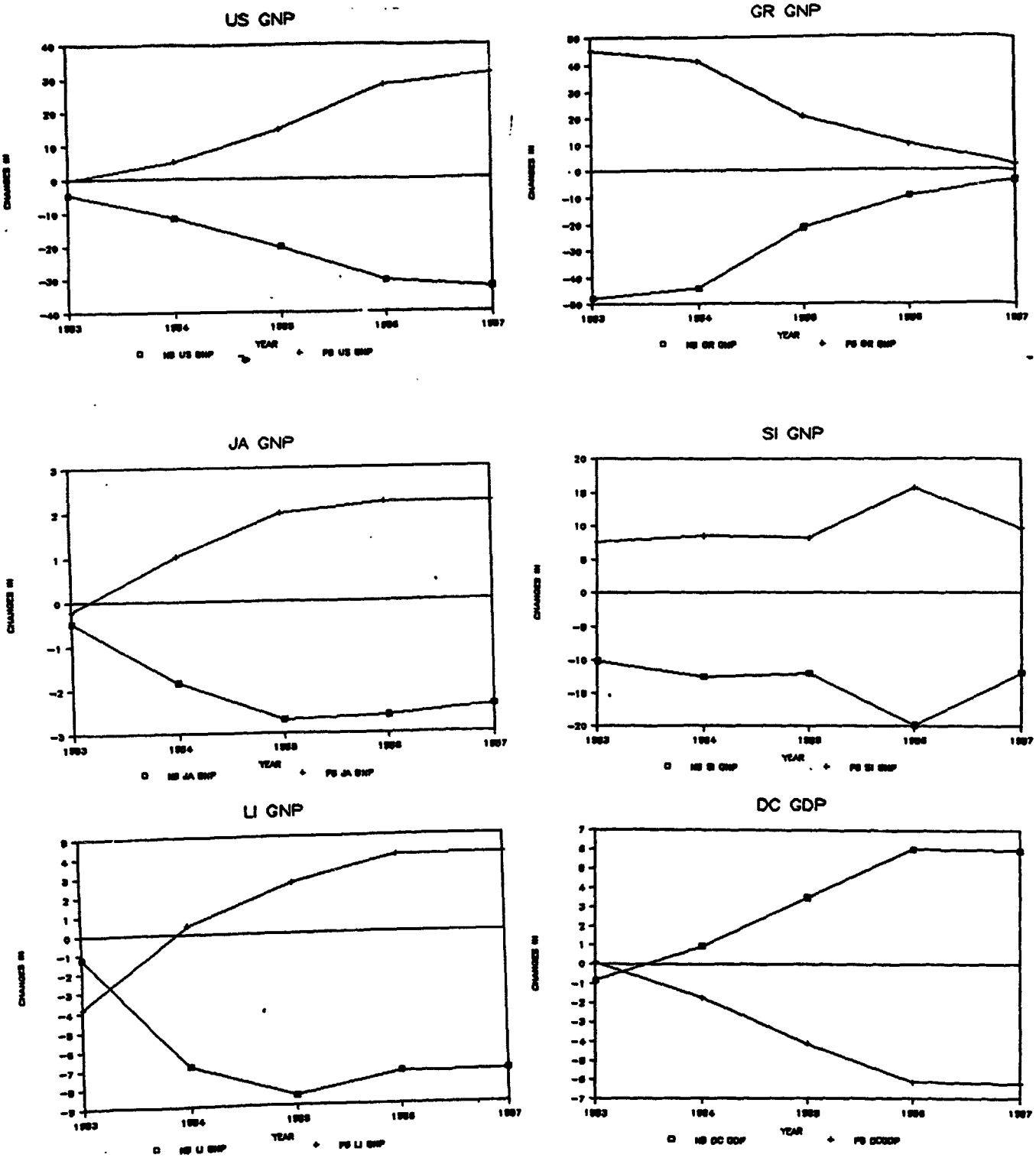


FIGURE 6.2

GNP Deflators Deviations from the Base Run, for Six Blocks, After (+/-) Five Percent Changes in the Germany's Real Government Expenditures in MULTIMOD

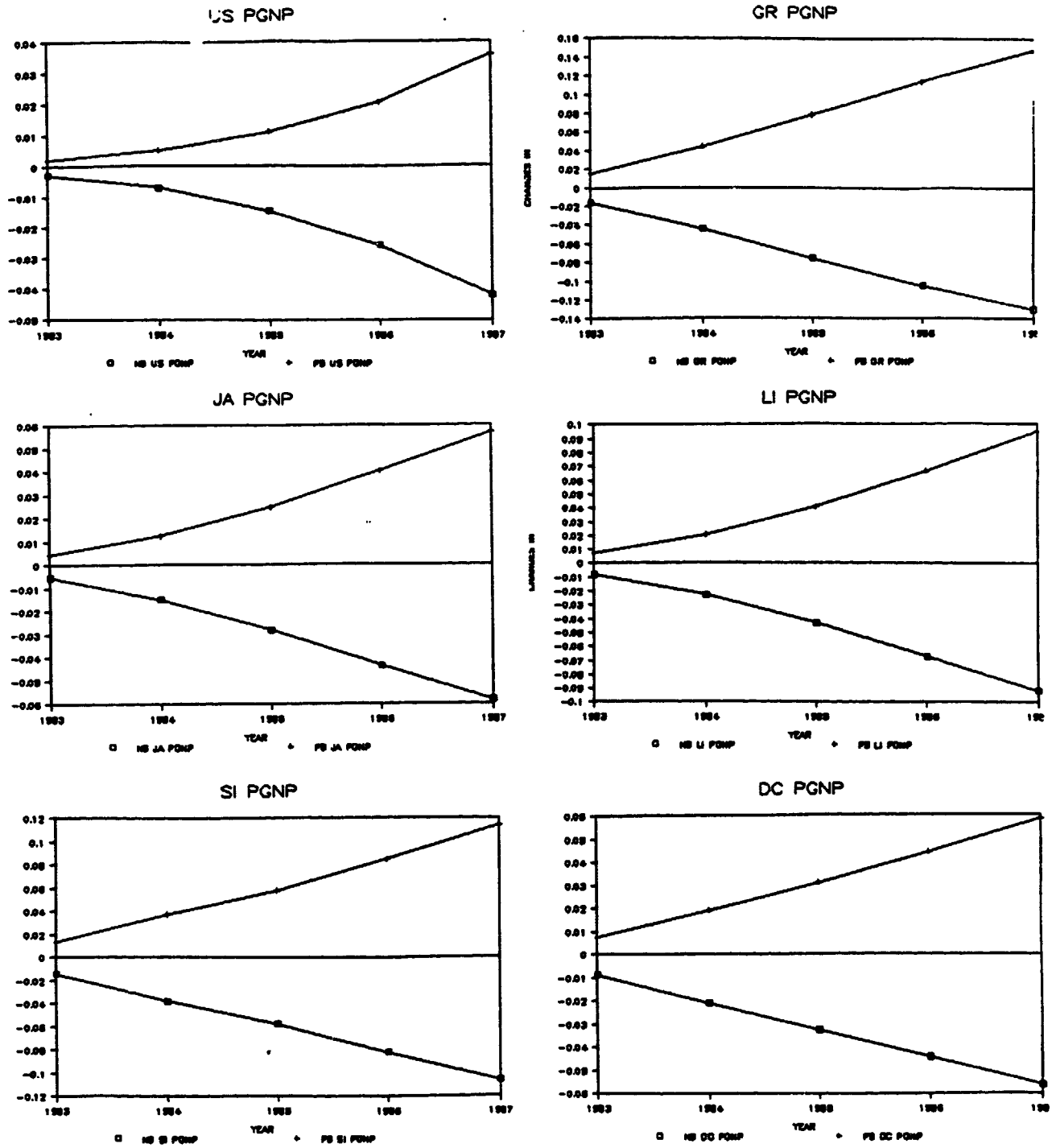


FIGURE 7.1

GNP/GDP Deviations from the Base Run, for Six Blocks, After (+/-) 10 Percent Changes in the United States Target Monetary Base in MULTIMOD

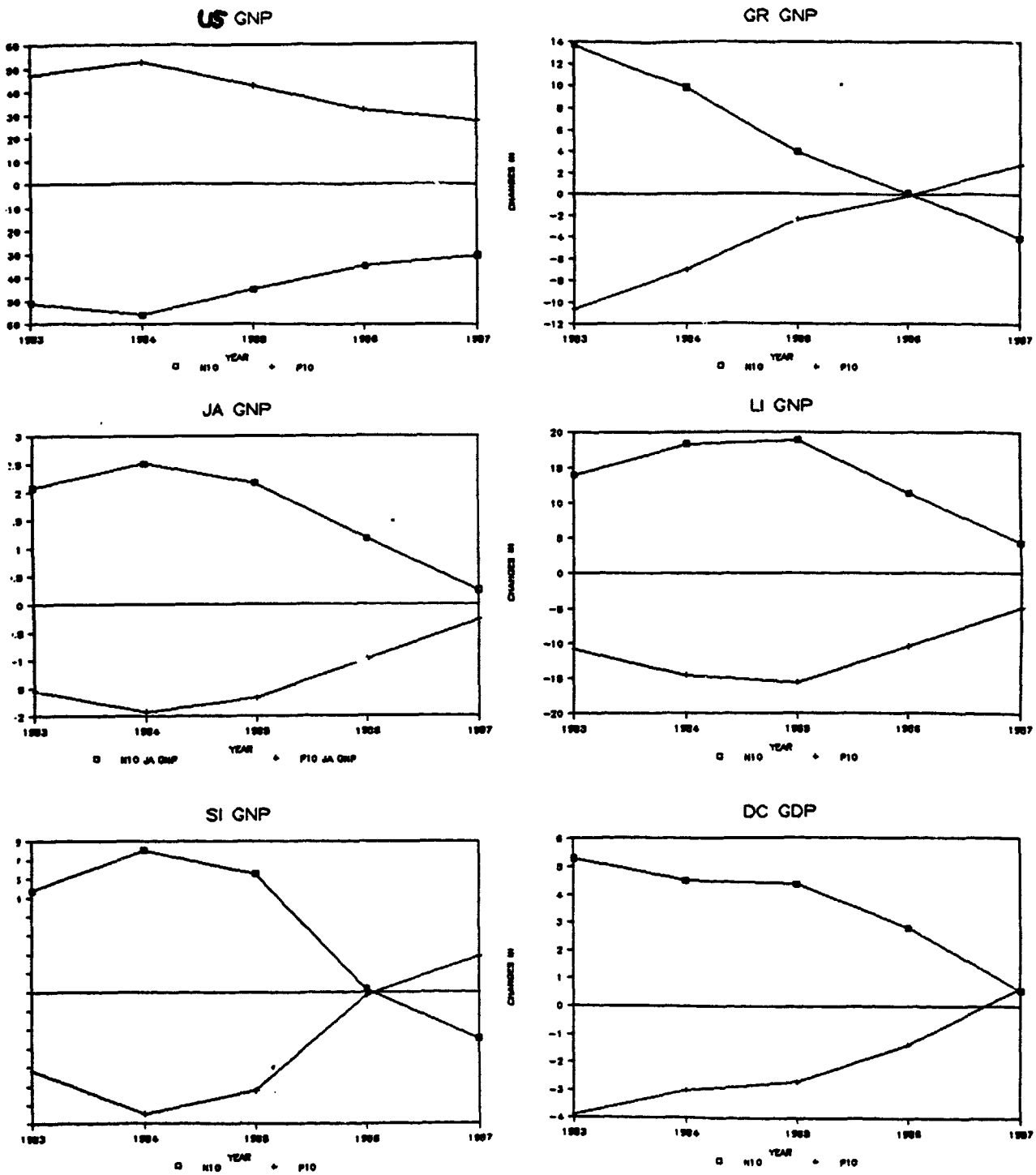
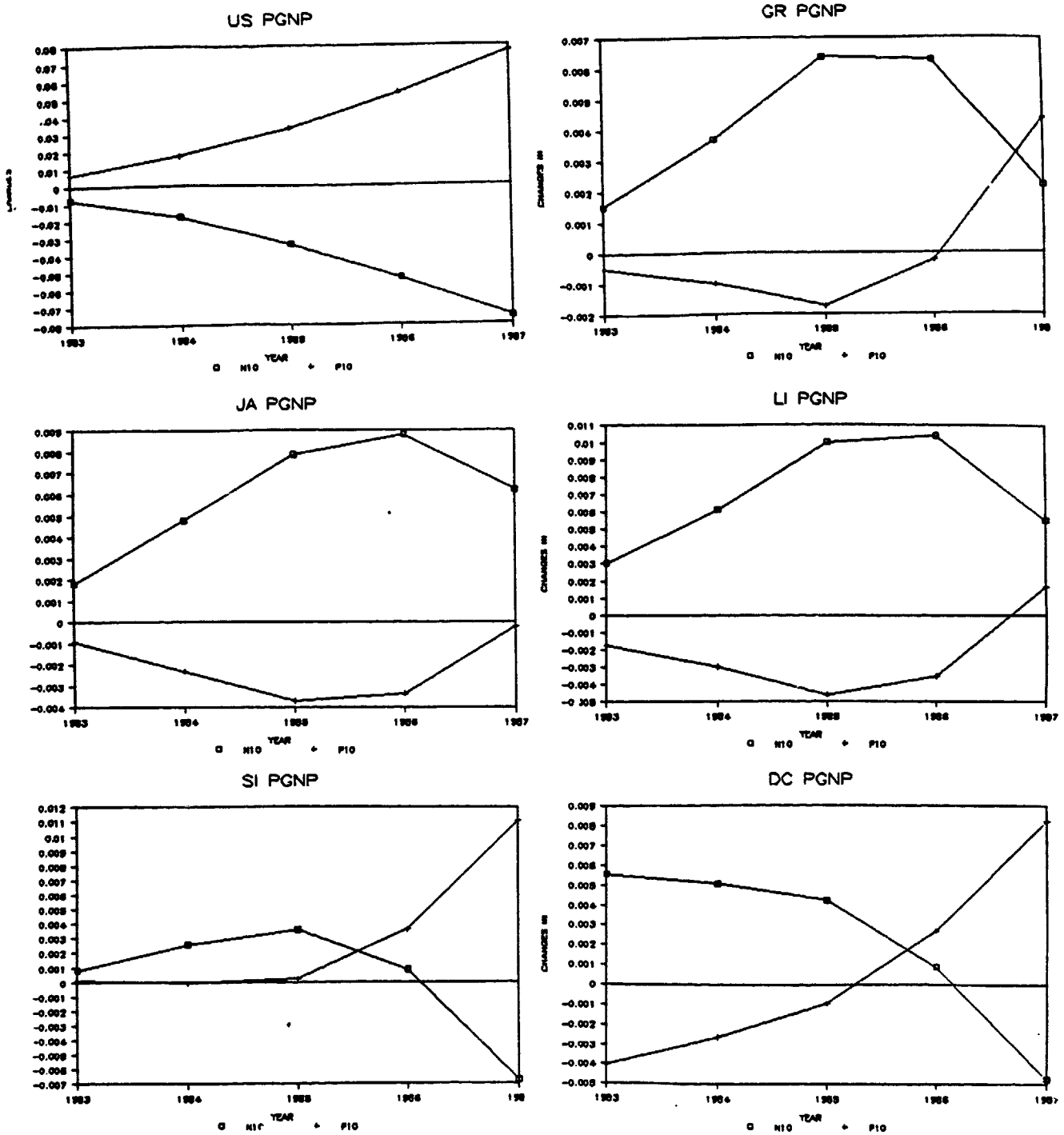


FIGURE 7.2

GNP Deflator Deviations from the Base Run, for Six Blocks, After (+/-) 10 Percent Changes in the United States Target Monetary Base in MULTIMOD



monetary perturbations. Second, the behavior of the model with respect to both perturbations is increasingly nonlinear when the perturbation becomes more negative.

B. Sensitivity Analysis of the Model

This section investigates the structural sensitivity of MULTIMOD. Specifically, by sensitivity we mean changes in the time path of the endogenous variable(s) induced (1) by changes in the parameter values (parameter sensitivity analysis), (2) by changes in the exogenous variables (multiplier analysis), and (3) by the presence of lagged or lead variables (homogeneous dynamics analysis). We start with some details regarding structural sensitivity analysis and, in the next part, present some empirical results for MULTIMOD.

1. Sensitivity

The general nonlinear dynamic model may be written as

$$f(y_t, y_{t-1}, y_{t+1}, x_t, \beta) = 0 \tag{8}$$

where f = a vector-valued function which may be nonlinear;

y_t = the vector of current endogenous variables;

y_{t-1} = the vector of endogenous variables lagged one period;

y_{t+1} = the vector of endogenous variables with a one-period lead;

x_t = the vector of current exogenous variables; and

β = the vector of constant coefficients.

Linearizing the model by taking the first order Taylor-series approximation in the neighborhood of the baseline simulation time path, we get

$$E\Delta y_t = F\Delta y_{t-1} + G\Delta y_{t+1} + H\Delta x_t + J\Delta\beta \tag{9}$$

where Δ stands for deviation in the vicinity of baseline simulation time path, and

$$E \equiv \left(\frac{\partial f}{\partial y_t}\right);$$

$$F \equiv \left(\frac{\partial f}{\partial y_{t-1}}\right);$$

$$G \equiv \left(\frac{\partial f}{\partial y_{t+1}}\right);$$

$$H \equiv \left(\frac{\partial f}{\partial x_t}\right); \text{ and}$$

$$J \equiv \left(\frac{\partial f}{\partial \beta}\right).$$

It may be noted that, in general, the matrices of first derivatives E, F, G, H, and J are functions of y_t, y_{t-1}, y_{t+1}, x_t, and β, and vary with time.

Premultiplying equation (9) by E^{-1}, we get the reduced form of the deviation model as

$$\Delta y_t = A\Delta y_{t-1} + B\Delta y_{t+1} + C\Delta x_t + D\Delta\beta \tag{10}$$

where $A = E^{-1}F$, etc.

Equation (10) shows that the "sensitivity," that is, the deviation from the baseline of the endogenous variable y_t is composed of

- Parameter perturbation effects, $D\Delta\beta$;
- Multiplier effects $C\Delta x_t$; and
- Homogeneous dynamics governed by lagged term $A\Delta y_{t-1}$ and forward term $B\Delta y_{t+1}$.

This decomposition is exhibited schematically in Diagram 1.

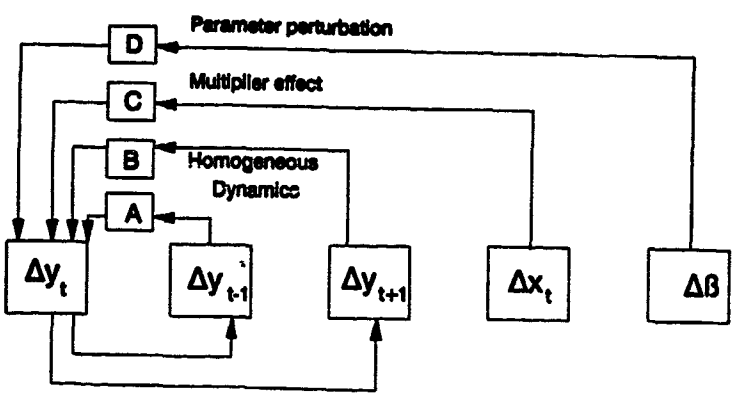


Diagram 1

2. Tools of Estimation

LIMO is a "task" within TROLL that provides sensitivity analysis of dynamic system models.[33] It takes a nonlinear TROLL model as an input and provides a linearized solution by evaluating the first order derivatives around the simulation path. This solution then becomes the basis for linear analysis. It may be noted that, once the nonlinear model is linearized at a particular point in time, the perturbation-related terms ($C\Delta x_t$ and $D\Delta\beta$) remain fixed, and the dynamic behavior of the linearized model is governed by the matrices A and B. LIMO implements parameter sensitivity, multiplier and dynamic analyses by diagonalizing these matrices through their characteristic roots and vectors.

TESTMOD is another TROLL task that provides more limited sensitivity tests of dynamic simultaneous equation systems. The major difference between LIMO and TESTMOD is the estimation of linearized model solutions by LIMO prior to any sensitivity analysis. However, for models which are reasonably linear, the solutions of the two TROLL tasks are generally very close.

3. Results

This part examines the structural sensitivity of MULTIMOD. The parameter perturbation results are presented first, followed by the multiplier analysis results. To facilitate the interpretation and comparability of the results, the deviation of the results from the baseline are reported in elasticity-scaled form.[34]

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[33] See TROLL Program, LIMO, Technical Report No. 34, 1983, and TROLL Program TESTMOD, Peter L.B. Hollinger and John Neese.

[34] Elasticity is one form of scaling. Depending on the nature and units of the variables involved, different forms of scaling may be employed, for example, ratio scaling, beta scaling (See Pindyck (1985). For details on elasticity scaling, see Kuh, *et al*, (1985).

a. Parameter Sensitivity

For purposes of simplicity as well as economy of computer resources, the parameter sensitivity analysis of MULTIMOD has been limited, in the current study, to the money demand equations, which have the following form:

$$\ln(M/P) = m_0 + m_1 \ln(GNP) + m_2 RS + m_3 RS_{-1} + m_4 \ln(M_{-1}/P_{-1})$$

where M/P denotes real balances and RS denotes the short-term interest rate. Parameter perturbations are calculated by comparing a baseline simulation to a series of simulations in which the money demand coefficients are perturbed, one at a time, by 1 percent.[35]

The elasticity responses to perturbations of the five coefficients are exhibited in Table 14 for GNP and PGNP price deflator (the results for three other endogenous variables are exhibited in Appendix B), and in each case, for three different blocks. With some exceptions (e.g., GNP deflators), the elasticity responses reached their respective first peaks in the second period. The GNP deflators reached their first peaks in the third period. The majority of elasticities damp down beyond the second and third periods. In some cases, after experiencing a trough, the elasticity responses reached a second peak in period 8 or 9 (e.g., GNP deflator).

As is evident from Table 14, the properties of the dynamic coefficients are of primary importance in determining the elasticities. The endogenous variables listed in the table respond with greater elasticities and higher oscillations to the perturbation of m_4 the coefficient of the

[35]Kuh and Neese (1979) examined perturbations of the order of 0.001, 0.01, 0.1, 1, 10, and 20 percent. But, after weighing conflicting numerical and analytical considerations, they finally selected a perturbation by 1 percent as being nearly optimal, because it was sufficiently large to produce changes in the time paths of endogenous variables which were clearly distinguishable from rounding errors without being too large to invalidate the arc approximations to the actual elasticities. Further, it was sufficiently small so that the higher order terms arising out of nonlinearities could be considered negligible.

Table 14

PERTURBATION OF THE PARAMETERS OF THE MONEY DEMAND EQUATIONS
AND THE ELASTICITY RESPONSES OF GNPs

1. GNP

REFERENCE VARIABLE	PERTURBED COEFFICIENT	PERIOD 1	2	3	4	5	6	7	8	9	10
INTERCEPT	JA	- 0.14	- 0.45	- 0.02	- 0.06	0.02	0.06	0.07	0.05	0.03	0.01
	M0 LI	- 0.14	- 0.43	- 0.22	- 0.09	- 0.02	- 0.01	0	0	0	0
	US	0.31	0.20	0.22	0.17	0.15	0.13	0.12	0.09	0.08	0.06
ln(GNP)	JA	0.62	1.91	0.90	0.30	- 0.11	- 0.20	- 0.31	- 0.26	- 0.13	- 0.07
	M1 LI	0.59	1.35	0.97	0.39	0.05	0.02	- 0.05	- 0.05	0	0.03
	US	- 1.36	- 0.85	- 0.98	- 0.83	- 0.76	- 0.61	- 0.52	- 0.51	- 0.44	- 0.17
RS	JA	- 0.03	- 0.08	- 0.04	- 0.02	0	0.01	0.01	0.01	0	0
	M2 LI	- 0.02	- 0.08	- 0.04	- 0.02	0	0	0	0	0	0
	US	0.05	0.04	0.04	0.03	0.02	0.02	0.01	0	0	0
RS(-1)	JA	- 0.03	- 0.08	- 0.03	- 0.01	0	0.01	0.01	0.01	0	0
	M3 LI	- 0.02	- 0.08	- 0.04	- 0.01	0	0	0	0	0	0
	US	0.06	0.04	0.04	0.03	0.03	0.02	0.01	0	0	0
ln(M(-1)/P(-1))	JA	2.10	5.91	2.34	- 0.02	- 1.66	- 1.97	- 1.47	- 0.38	1.14	2.31
	M4 LI	1.82	5.87	3.24	1.41	0.18	0.17	- 0.84	- 1.14	- 1.12	- 1.05
	US	- 4.31	- 2.73	- 3.05	- 2.47	- 2.03	- 1.41	- 1.11	- 1.06	- 0.99	0.75

*Values less than .01 are reported as zero.

Table 14

PERTURBATION OF THE PARAMETERS OF THE MONEY DEMAND EQUATIONS
AND THE ELASTICITY RESPONSES OF PGNPs

2. GNP Deflator (PGNP)

REFERENCE VARIABLE	PERTURBED COEFFICIENT	PERIOD 1	2	3	4	5	6	7	8	9	10
INTERCEPT	JA	- 0.07	- 0.17	- 0.25	- 0.24	- 0.14	0.03	0.23	0.43	0.62	0.78
	M0 LI	- 0.08	- 0.17	- 0.22	- 0.18	0.06	0.11	0.31	0.51	0.67	0.82
	US	0.11	0.22	0.39	0.61	0.87	1.16	1.46	1.76	2.06	2.32
ln(GNP)	JA	0.29	0.76	1.13	1.11	0.66	- 0.05	- 0.92	- 1.81	- 2.57	- 3.18
	M1 LI	0.35	0.75	1.02	0.87	0.31	- 0.43	- 1.28	- 2.12	- 2.15	- 3.42
	US	- 0.44	- 0.92	- 1.64	- 2.57	- 3.67	- 4.87	- 6.15	- 7.44	- 8.69	- 9.85
RS	JA	- 0.01	- 0.02	- 0.04	- 0.03	- 0.01	0.02	0.06	0.10	0.13	0.15
	M2 LI	- 0.01	- 0.03	- 0.03	- 0.02	0	0.04	0.08	0.11	0.13	0.15
	US	0.02	0.04	0.07	0.10	0.15	0.21	0.26	0.26	0.31	0.35
RS(-1)	JA	0.01	- 0.03	- 0.04	- 0.03	- 0.01	0.02	0.06	0.10	0.13	0.15
	M3 LI	0.01	- 0.03	- 0.04	- 0.02	0	0.03	0.08	0.11	0.14	0.16
	US	0.02	0.04	0.08	0.12	0.17	0.22	0.27	0.32	0.37	0.41
ln(M(-1)/P(-1))	JA	1.03	2.73	4.03	3.88	2.02	- 1.07	- 4.92	- 8.75	- 11.83	- 13.69
	M4 LI	0.92	2.17	3.06	2.98	1.84	0.19	- 1.95	- 4.27	- 6.55	- 8.54
	US	- 1.39	- 2.97	- 5.29	- 8.17	- 11.50	- 15.00	- 18.51	- 21.99	- 25.26	- 28.21

autoregressive term, than to the perturbation of other coefficients.[36] After m_4 the other dominant coefficients are m_1 and the intercept term m_0.

The magnitude of many elasticities in Table 14 is lower than 0.10. These responses may be interpreted as insignificant, although they help us in detecting the trend of the responses. This is especially true for m_2 and m_3.

b. Multipliers

Two exogenous variables, US government expenditures and US target monetary base, were perturbed in order to study the multiplier effects on the endogenous variables of the model. Each perturbation is an unanticipated one percent increase in the exogenous variable relative to that of the baseline-year for the first period (impulse multiplier). Tables 15 and 16 summarize the responses of the major endogenous variables to each perturbation.

TESTMOD, rather than LIMO, was used to estimate the multiplier responses as the linearity tests of the model (Section IV.A.2) were sufficientlyconvincing to warrant the use of the less computation-intensive TROLL task. However, it limited the measurement of the multiplier responses, reported in Tables 15 and 16, to arc elasticities at each time period.

A general comparison between the responses of the government expenditures and monetary base perturbations reveals that the elasticity responses are higher and last longer for the former. The largest effects (peaks) are usually completed by the third or fourth period for the monetary perturbation, whereas, for some variables, they last longer for the government perturbation. With few exceptions the majority of elasticities did not exceed unity in either case.

Most of the endogenous variables responded immediately to the perturbations. Important variables to show a delayed response were developing countries debt and long-term interest rates.

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[36] "Also, the magnitudes of the dynamic parameters determine the interim elasticity scaling. Interim elasticity is the time path followed by percent change in y in response to a once-and-for-all percentage or amount changes of a coefficient, or in response to a one period perturbation of x_t, say at time t, with unchanged coefficients. The interim elasticity in the first period (t=1) is the same as impact elasticity. For sluggish dynamics (when dynamic coefficients are positive and close to one) interim elasticities remain close to their impact values; for swift dynamics (when dynamic coefficients are close to zero) the impact elasticities soon decay." See Kuh, *et al*, (1985), p.33.

TABLE 15

	PERIODS									
	1	2	3	4	5	6	7	8	9	10
UNITED STATES										
REAL GNP	0.32	0.06	-0.01	-0.03	-0.02	-0.02	-0.02	-0.01	-0.	0.
REAL DOMESTIC DEMAND	0.34	0.08	0.	-0.01	-0.01	-0.01	-0.01	-0.	0.	0.
GROSS INVESTMENT	0.33	0.33	0.03	-0.06	-0.04	-0.03	-0.02	-0.01	0.	0.01
GNP DEFLATOR 1	0.02	0.08	0.14	0.17	0.18	0.18	0.17	0.15	0.12	0.1
INFLATION RATE	0.23	0.61	0.84	0.92	0.41	0.1	-0.48	-0.52	-0.59	-0.59
MANUFACTURING EXPORT PRICES	0.01	0.06	0.11	0.15	0.17	0.17	0.17	0.15	0.13	0.11
SH TERM INTEREST RATE,NOMINAL	0.39	0.13	0.14	0.19	0.2	0.27	0.32	0.3	0.26	0.22
LONG TERM INTEREST RATE,NOMINAL	0.03	-0.23	-0.27	-0.31	-0.32	-0.34	-0.37	-0.36	-0.34	-0.32
NOMINAL EFFECTIVE EXCHANGE RATE	0.04	0.01	-0.02	-0.05	-0.08	-0.1	-0.1	-0.1	-0.1	-0.1
CURRENT ACCOUNT BALANCE	-87.82	-7.77	2.95	0.55	0.33	0.36	0.3	0.26	0.27	0.26
GOV. FINANCIAL BALANCE	10.07	0.32	0.53	0.55	0.54	0.49	0.44	0.52	0.48	0.48
GERMANY:										
REAL GNP	0.03	0.04	0.04	0.04	0.03	0.03	0.01	0.01	0.01	0.01
REAL DOMESTIC DEMAND	0.01	0.03	0.04	0.03	0.03	0.02	0.01	0.	-0.	-0.
GROSS INVESTMENT	0.03	0.09	0.1	0.09	0.08	0.05	0.03	0.01	0.	0.
GNP DEFLATOR 1	0.	0.	0.	0.01	0.02	0.03	0.04	0.04	0.03	0.03
INFLATION RATE	0.18	0.02	-0.02	0.17	0.37	0.46	0.4	-0.01	-0.04	0.07
MANUFACTURING EXPORT PRICES	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.03	0.04
SH TERM INTEREST RATE,NOMINAL	0.06	0.05	0.08	0.13	0.13	0.15	0.14	0.14	0.14	0.12
LONG TERM INTEREST RATE,NOMINAL	0.	-0.33	-0.35	-0.37	-0.37	-0.38	-0.39	-0.38	-0.36	-0.33
EXCHANGE RATE	-0.05	-0.03	0.01	0.04	0.07	0.09	0.09	0.09	0.08	0.07
NOMINAL EFFECTIVE EXCHANGE RATE	-0.01	-0.03	-0.01	-0.	0.01	0.01	0.01	0.	-0.	-0.01
CURRENT ACCOUNT BALANCE	-0.41	0.86	0.4	0.89	0.72	0.53	0.36	0.37	0.38	0.38
GOV. FINANCIAL BALANCE	-0.19	-0.19	-0.32	-0.44	-0.6	-0.86	-0.64	-0.38	-0.21	-0.24
JAPAN:										
REAL GNP	0.04	0.04	0.05	0.05	0.04	0.03	0.01	-0.	-0.01	-0.01
REAL DOMESTIC DEMAND	0.02	0.04	0.04	0.04	0.03	0.02	0.01	-0.	-0.	-0.01
GROSS INVESTMENT	0.02	0.06	0.06	0.07	0.06	0.05	0.03	0.01	0.	-0.01
GNP DEFLATOR 1	0.	0.	0.	0.01	0.02	0.03	0.05	0.05	0.06	0.06
INFLATION RATE	0.15	-0.01	0.02	0.33	0.69	0.93	-3.77	-1.27	0.09	-0.04
MANUFACTURING EXPORT PRICES	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04
SH TERM INTEREST RATE,NOMINAL	0.06	0.09	0.12	0.13	0.14	0.14	0.16	0.17	0.12	0.1
LONG TERM INTEREST RATE,NOMINAL	0.01	-0.36	-0.37	-0.38	-0.38	-0.38	-0.38	-0.37	-0.35	-0.32
EXCHANGE RATE	-0.03	-0.03	0.01	0.05	0.08	0.11	0.12	0.12	0.12	0.1
NOMINAL EFFECTIVE EXCHANGE RATE	-0.01	-0.03	-0.01	0.02	0.04	0.06	0.07	0.07	0.07	0.06
CURRENT ACCOUNT BALANCE	-1.34	-0.44	1.1	0.6	0.54	0.44	0.32	0.3	0.26	0.21
GOV. FINANCIAL BALANCE	-0.19	-0.19	-0.32	-0.44	-0.6	-0.86	-0.64	-0.38	-0.21	-0.24
OTHER LARGE INDUSTRIAL COUNTRIES:										
REAL GNP	0.04	0.04	0.05	0.05	0.05	0.04	0.03	0.02	0.01	0.
REAL DOMESTIC DEMAND	0.02	0.04	0.04	0.04	0.03	0.03	0.01	0.01	0.	-0.01
GROSS INVESTMENT	0.04	0.1	0.11	0.11	0.09	0.08	0.05	0.03	0.01	-0.01
GNP DEFLATOR 1	0.	0.01	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.04
INFLATION RATE	0.07	0.04	0.14	0.35	0.21	0.06	-0.04	-0.06	-0.06	-0.01
MANUFACTURING EXPORT PRICES	0.01	0.01	0.02	0.03	0.04	0.04	0.04	0.04	0.03	0.03
SH TERM INTEREST RATE,NOMINAL	0.05	0.07	0.06	0.09	0.1	0.1	0.09	0.08	0.06	0.05
LONG TERM INTEREST RATE,NOMINAL	0.	-0.22	-0.25	-0.27	-0.28	-0.29	-0.3	-0.29	-0.28	-0.26
EXCHANGE RATE	-0.04	-0.01	0.02	0.04	0.06	0.08	0.08	0.09	0.09	0.09
NOMINAL EFFECTIVE EXCHANGE RATE	-0.01	-0.01	-0.01	-0.01	-0.01	-0.	0.01	0.01	0.01	0.02
CURRENT ACCOUNT BALANCE	-3.35	1.26	-0.79	2.86	12.52	-312.82	-25.15	-1.61	-1.04	-0.69
GOV. FINANCIAL BALANCE	-0.2	-0.16	-0.21	-0.23	-0.25	-0.25	-0.22	-0.22	-0.21	-0.18

MULTIPLIER ELASTICITY RESPONSES TO US GOVERNMENT PERTURBATION
TABLE 15

	1	2	3	4	5	6	7	8	9	10
SMALL INDUSTRIAL COUNTRIES:										
REAL GNP	0.03	0.02	0.03	0.04	0.04	0.03	0.02	0.02	0.01	0.
REAL DOMESTIC DEMAND	0.02	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.	-0.
GROSS INVESTMENT	0.03	0.08	0.08	0.1	0.11	0.09	0.06	0.04	0.02	0.
GNP DEFLATOR 1	0.	-0.01	-0.02	-0.02	-0.02	-0.01	-0.	-0.	-0.	-0.
INFLATION RATE	0.12	-0.28	-0.13	-0.02	0.11	0.71	0.01	-0.03	-0.05	0.05
MANUFACTURING EXPORT PRICES	0.01	-0.01	-0.02	-0.02	-0.01	-0.	0.	-0.	-0.	-0.
SH TERM INTEREST RATE,NOMINAL	0.05	0.01	0.01	0.01	0.04	0.02	0.04	0.03	0.01	0.
LONG TERM INTEREST RATE,NOMINAL	0.	-0.22	-0.25	-0.25	-0.25	-0.26	-0.26	-0.26	-0.25	-0.23
EXCHANGE RATE	-0.04	0.01	0.06	0.09	0.11	0.13	0.13	0.13	0.12	0.12
NOMINAL EFFECTIVE EXCHANGE RATE	-0.01	0.03	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
CURRENT ACCOUNT BALANCE	-0.4	0.41	-0.08	-1.43	1.3	28.39	-7.86	-0.51	-0.75	-0.73
GOV. FINANCIAL BALANCE	-0.16	-0.11	-0.18	-0.22	-0.26	-0.22	-0.26	-0.24	-0.23	-0.22
DEVELOPING COUNTRIES:										
REAL GDP	0.02	0.	0.	0.01	0.01	0.01	0.01	0.01	0.01	0.01
REAL DOMESTIC DEMAND	0.03	-0.03	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.01
TL CON. EXP. INCL. PUBLIC	0.01	-0.01	-0.	0.01	0.02	0.02	0.02	0.02	0.02	0.02
GROSS INVESTMENT	0.07	-0.09	0.04	0.06	0.06	0.05	0.03	0.02	0.01	0.01
GNP DEFLATOR 1	0.03	0.03	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04
MANUFACTURING EXPORT PRICES	0.02	0.03	0.04	0.04	0.05	0.06	0.05	0.05	0.04	0.04
STOCK OF DEBT	-0.	-0.17	-0.14	-0.11	-0.08	-0.05	-0.03	-0.01	0.	0.01
STOCK OF NET DEBT	-0.04	-0.16	-0.16	-0.15	-0.13	-0.11	-0.09	-0.07	-0.05	-0.04
VOLUME OF TOTAL IMPORTS	0.11	-0.14	0.04	0.08	0.1	0.1	0.07	0.06	0.05	0.04
VOLUME OF MFG EXPORTS	0.12	0.04	0.03	0.03	0.03	0.02	0.01	0:01	0.01	0.01
HIGH INCOME OIL PRODUCERS:										
REAL GDP	0.13	0.02	0.05	0.05	0.04	0.02	0.01	0.01	0.	-0.
REAL DOMESTIC ABSORPTION	0.05	0.08	0.07	0.05	0.05	0.02	0.01	-0.	-0.02	-0.02
TOTAL EXPORT PRICES	0.07	0.1	0.1	0.08	0.07	0.05	0.02	-0.01	-0.03	-0.05
VOLUME OF TOTAL IMPORTS	0.19	0.	0.07	0.08	0.07	0.06	0.03	0.02	0.01	0.01
VOLUME OF OIL EXPORTS	-0.01	0.02	0.07	0.1	0.13	0.14	0.15	0.14	0.13	0.12
INTERNATIONAL PRICES 1/:										
PRICE OF OIL IN DOLLARS	0.28	0.02	0.06	0.08	0.11	0.13	0.11	0.12	0.12	0.11
PRICE INDEX OF COMMODITIES	0.	0.	-0.	0.	-0.	0.	0.	0.	0.	0.

1/ DENOMINATED INDICES IN TERMS OF US DOLLARS.

MULTIPLIER ELASTICITY RESPONSES TO US MONETARY BASE 1% PERTURBATION
TABLE 16

	1	2	3	4	5	6	7	8	9	10
UNITED STATES										
REAL GNP	0.02	0.01	0.03	0.03	0.02	0.02	0.01	0.01	0.02	0.02
REAL DOMESTIC DEMAND	0.01	0.01	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
GROSS INVESTMENT	0.03	0.06	0.08	0.08	0.06	0.05	0.03	0.02	0.03	0.03
GNP DEFLATOR 1	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01
INFLATION RATE	0.13	-0.08	0.1	0.17	0.14	0.09	-0.13	-0.13	-0.12	-0.04
MANUFACTURING EXPORT PRICES	0.04	0.	0.01	0.02	0.02	0.03	0.02	0.02	0.01	0.01
SH TERM INTEREST RATE,NOMINAL	-1.14	0.01	0.05	0.06	0.06	0.07	0.07	0.07	0.06	0.06
LONG TERM INTEREST RATE,NOMINAL	-0.1	-0.3	-0.34	-0.37	-0.38	-0.41	-0.43	-0.41	-0.38	-0.34
NOMINAL EFFECTIVE EXCHANGE RATE	-0.13	-0.01	-0.03	-0.06	-0.08	-0.09	-0.09	-0.1	-0.09	-0.08
CURRENT ACCOUNT BALANCE	3.09	-3.04	-0.35	0.07	0.04	0.02	-0.04	-0.05	-0.09	-0.13
GOV. FINANCIAL BALANCE	-0.24	-1.94	-0.31	-0.28	-0.43	-0.35	-0.29	-0.43	-0.45	-0.52
GERMANY:										
REAL GNP	-0.01	0.02	0.05	0.04	0.02	0.01	0.01	0.	0.	0.01
REAL DOMESTIC DEMAND	-0.	0.02	0.04	0.04	0.02	0.01	0.01	0.	0.	0.
GROSS INVESTMENT	-0.01	0.04	0.11	0.1	0.07	0.04	0.02	0.01	0.01	0.02
GNP DEFLATOR 1	-0.	-0.01	-0.02	-0.03	-0.03	-0.03	-0.03	-0.04	-0.03	-0.03
INFLATION RATE	-0.13	-0.02	-0.33	-0.3	-0.14	0.11	-1.74	-0.01	0.2	0.48
MANUFACTURING EXPORT PRICES	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.03	-0.02
SH TERM INTEREST RATE,NOMINAL	-0.03	0.01	0.04	0.01	-0.03	-0.04	-0.08	-0.11	-0.09	-0.04
LONG TERM INTEREST RATE,NOMINAL	-0.	-0.38	-0.41	-0.43	-0.44	-0.44	-0.44	-0.43	-0.4	-0.37
EXCHANGE RATE	0.14	-0.	0.03	0.05	0.07	0.08	0.08	0.08	0.07	0.06
NOMINAL EFFECTIVE EXCHANGE RATE	0.04	-0.02	-0.	0.	0.01	0.01	0.01	-0.	-0.01	-0.01
CURRENT ACCOUNT BALANCE	0.06	1.12	0.55	0.03	0.23	0.18	0.14	0.12	0.11	0.1
GOV. FINANCIAL BALANCE	0.06	-0.09	-0.35	-0.41	-0.49	-0.57	-0.39	-0.18	-0.11	-0.16
JAPAN:										
REAL GNP	-0.01	0.01	0.05	0.04	0.03	0.02	0.	-0.01	-0.01	-0.01
REAL DOMESTIC DEMAND	-0.	0.02	0.04	0.04	0.03	0.02	0.	-0.	-0.	-0.
GROSS INVESTMENT	-0.	0.02	0.06	0.07	0.05	0.04	0.02	0.	0.	-0.
GNP DEFLATOR 1	-0.	-0.02	-0.03	-0.04	-0.04	-0.04	-0.04	-0.03	-0.02	-0.01
INFLATION RATE	-0.05	-0.25	-0.78	-1.07	-0.36	0.13	-1.23	-1.29	1.02	0.71
MANUFACTURING EXPORT PRICES	-0.	-0.	-0.02	-0.04	-0.05	-0.05	-0.05	-0.05	-0.04	-0.03
SH TERM INTEREST RATE,NOMINAL	-0.01	0.	0.05	0.01	-0.03	-0.05	-0.1	-0.15	-0.1	-0.07
LONG TERM INTEREST RATE,NOMINAL	-0.	-0.42	-0.44	-0.46	-0.46	-0.45	-0.45	-0.43	-0.39	-0.36
EXCHANGE RATE	0.11	-0.02	0.01	0.04	0.08	0.1	0.11	0.11	0.11	0.09
NOMINAL EFFECTIVE EXCHANGE RATE	0.05	-0.03	-0.01	0.01	0.04	0.06	0.07	0.07	0.06	0.05
CURRENT ACCOUNT BALANCE	0.07	-2.26	1.04	0.16	0.18	0.1	0.07	0.05	-0.02	-0.05
GOV. FINANCIAL BALANCE	0.06	-0.09	-0.35	-0.41	-0.49	-0.57	-0.39	-0.18	-0.11	-0.16
OTHER LARGE INDUSTRIAL COUNTRIES:										
REAL GNP	-0.01	0.02	0.06	0.05	0.03	0.02	0.01	0.01	0.01	0.
REAL DOMESTIC DEMAND	-0.	0.03	0.05	0.05	0.03	0.02	0.01	0.	0.	-0.
GROSS INVESTMENT	-0.01	0.05	0.11	0.13	0.09	0.07	0.03	0.02	0.01	0.
GNP DEFLATOR 1	-0.	-0.01	-0.02	-0.02	-0.03	-0.04	-0.04	-0.05	-0.04	-0.03
INFLATION RATE	-0.04	-0.05	-0.13	-0.2	-0.13	-0.09	-0.13	-0.04	0.09	0.34
MANUFACTURING EXPORT PRICES	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.03
SH TERM INTEREST RATE,NOMINAL	-0.01	0.01	0.03	0.02	0.01	-0.01	-0.04	-0.05	-0.05	-0.04
LONG TERM INTEREST RATE,NOMINAL	-0.	-0.27	-0.3	-0.33	-0.34	-0.35	-0.36	-0.34	-0.32	-0.29
EXCHANGE RATE	0.13	0.01	0.02	0.04	0.05	0.07	0.07	0.08	0.08	0.07
NOMINAL EFFECTIVE EXCHANGE RATE	0.04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.	0.	0.01	0.01
CURRENT ACCOUNT BALANCE	0.18	1.78	-0.91	0.34	1.3	-20.94	-10.28	-0.74	-0.59	-0.43
GOV. FINANCIAL BALANCE	0.01	-0.1	-0.26	-0.25	-0.26	-0.24	-0.23	-0.24	-0.25	-0.23

MULTIPLIER ELASTICITY RESPONSES TO US MONETARY BASE 1% PERTURBATION
TABLE 16

	1	2	3	4	5	6	7	8	9	10
SMALL INDUSTRIAL COUNTRIES:										
REAL GNP	-0.01	-0.	0.04	0.03	0.03	0.02	0.	0.	0.	0.
REAL DOMESTIC DEMAND	-0.	0.01	0.04	0.04	0.04	0.03	0.	0.	0.	0.
GROSS INVESTMENT	-0.	0.03	0.09	0.12	0.11	0.08	0.03	0.02	0.02	0.02
GNP DEFLATOR 1	-0.	-0.03	-0.06	-0.07	-0.08	-0.07	-0.07	-0.07	-0.07	-0.06
INFLATION RATE	-0.07	-0.37	-0.31	-0.23	-0.08	0.03	0.09	-0.01	0.1	0.3
MANUFACTURING EXPORT PRICES	-0.01	-0.03	-0.06	-0.07	-0.08	-0.07	-0.07	-0.07	-0.07	-0.06
SH TERM INTEREST RATE,NOMINAL	-0.01	-0.03	-0.02	-0.04	-0.08	-0.04	-0.12	-0.16	-0.15	-0.1
LONG TERM INTEREST RATE,NOMINAL	-0.	-0.26	-0.29	-0.3	-0.3	-0.31	-0.31	-0.3	-0.28	-0.26
EXCHANGE RATE	0.14	0.04	0.08	0.1	0.11	0.13	0.12	0.12	0.12	0.11
NOMINAL EFFECTIVE EXCHANGE RATE	0.04	0.04	0.06	0.07	0.07	0.07	0.06	0.06	0.06	0.06
CURRENT ACCOUNT BALANCE	0.02	0.6	-0.27	0.64	-0.37	17.6	12.4	0.49	0.22	-0.2
GOV. FINANCIAL BALANCE	-0.	-0.03	-0.24	-0.26	-0.31	-0.3	-0.3	-0.31	-0.33	-0.32
DEVELOPING COUNTRIES:										
REAL GDP	-0.	-0.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.
REAL DOMESTIC DEMAND	-0.	-0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01
TL CON. EXP. INCL. PUBLIC	-0.	-0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01
GROSS INVESTMENT	0.	-0.04	0.12	0.03	0.03	0.02	0.02	0.02	0.02	0.02
GNP DEFLATOR 1	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.03	-0.03
MANUFACTURING EXPORT PRICES	-0.	-0.01	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.03
STOCK OF DEBT	-0.	-0.11	-0.01	-0.	-0.	0.	0.	0.	0.	0.01
STOCK OF NET DEBT	0.01	-0.09	-0.03	-0.03	-0.02	-0.02	-0.01	-0.	0.	0.
VOLUME OF TOTAL IMPORTS	-0.	-0.06	0.17	0.07	0.07	0.06	0.05	0.05	0.05	0.04
VOLUME OF MFG EXPORTS	-0.02	0.02	0.04	0.03	0.02	0.01	0.01	0.	0.	0.
HIGH INCOME OIL PRODUCERS:										
REAL GDP	0.	-0.	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.01
REAL DOMESTIC ABSORPTION	0.01	0.01	0.02	0.03	0.03	0.01	0.02	0.02	0.03	0.03
TOTAL EXPORT PRICES	0.02	0.01	0.03	0.04	0.05	0.03	0.04	0.05	0.07	0.08
VOLUME OF TOTAL IMPORTS	0.	-0.01	0.14	0.09	0.07	0.04	0.02	0.02	0.01	0.01
VOLUME OF OIL EXPORTS	0.08	-0.	0.01	0.02	0.03	0.04	0.04	0.04	0.03	0.04
INTERNATIONAL PRICES 1/:										
PRICE OF OIL IN DOLLARS	0.1	0.04	0.12	0.07	0.05	0.04	0.02	0.04	0.05	0.05
PRICE INDEX OF COMMODITIES	0.	0.	-0.	0.	-0.	0.	0.	0.	0.	0.

V. Conclusion

The purpose of this paper was two-fold: to explore the potential usefulness of a multiregional macroeconometric model in the analysis of international macroeconomic policy issues that are of interest to IECAP and ultimately to the World Bank; and to investigate general techniques to understand the functioning of the models in respect of their theoretical underpinnings and structural properties.

Both of the above objectives were pursued in the context of MULTIMOD, a multiregional macroeconometric model developed and maintained by the IMF. MULTIMOD is relatively small in size and simple in its theoretical specification, but at the same time it represents the state-of-the art in macroeconometric modeling, exemplified by its "rational expectations" features. The estimation scheme employed emphasizes the comparability across country and regions through standardization of specifications and imposition of common coefficients. Thus, the differences in countries' responses to policy shocks are attributable to the differences in their structural features. However, the cross-country responses of the model are highly symmetric to the shocks originating from different countries or regions. The impact of the forward looking property of the model is reflected in the faster adjustment of all prices, including exchange rates, compared to conventional macroeconomic models. A major strength of the model is in the transmission of policy effects through alternative channels. In sum, based on the extensive multiplier analyses conducted in this study, MULTIMOD is a very useful tool for the examination of international macroeconomic relations.

MULTIMOD is one of the few models of its class to explicitly incorporate within its framework developing countries and high income oil exporting countries. As demonstrated in the paper, the model can be used in many ways to discuss key North-South issues, although this requires considerable adaptation of the model prior to simulation. There is scope for expanding

or strengthening the North-South linkages of the model so as to enhance its relevance to the discussion of North-South issues. Some of these possibilities are indicated below:

- Further disaggregation of the developing countries across specific groups, e.g. Highly Indebted Countries and Newly Industrialized Countries, would enhance the range of applications of the model.

- Formulation of alternative criteria for the creditworthiness of the developing countries would widen the scope for generating useful scenarios.

- Given the volatility and importance of the agricultural sector in North-South trade relations, disaggregation of the primary commodity trade into agriculture and other raw materials would increase the potential of the model, while reducing the extent of price distortions.

- The inclusion of inventory features in the commodity and oil markets should stabilize their unnecessary price fluctuations.

- Other enhancements worthy of consideration include further integration of developing countries into the international financial system, especially with regard to the recycling of surplus funds from High Income Oil Exporters and the NIE's and further disaggregation of the international sectors of the developing countries.

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Appendices

A. Effects of Selected Shocks in MULTIMOD, 1988-93: Tables A1 - A8

B. Parameter Perturbation of Money Demand Equations: Tables B1 - B3

EFFECTS OF A FIVE YEARS SUSTAINED INCREASE IN REAL U.S. GOVERNMENT EXPENDITURES BY ONE PERCENT OF GNP

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	1.14	0.30	2.11	0.16	-11.46	0.35	0.32	-2.31	0.10	0.21	0.29	0.35	-1.87	0.09	1.67	0.12	0.42	-1.86	0.08	3.60	0.22	0.50	0.74
1989	1.32	1.04	2.00	0.27	-16.62	0.45	0.93	-2.21	0.20	0.57	0.44	1.00	-1.78	0.20	3.53	0.21	1.15	-1.75	0.18	3.88	0.29	1.19	1.12
1990	1.26	2.17	1.89	0.41	-21.49	0.52	1.74	-2.11	0.31	1.94	0.51	1.85	-1.69	0.32	5.89	0.27	2.06	-1.64	0.31	4.11	0.36	2.07	0.10
1991	1.09	3.63	1.78	0.56	-27.98	0.52	2.66	-2.00	0.42	3.53	0.49	2.77	-1.59	0.43	8.33	0.27	3.02	-1.53	0.43	3.65	0.42	3.03	-1.23
1992	0.87	5.31	1.64	0.74	-35.46	0.46	3.57	-1.86	0.53	5.21	0.43	3.67	-1.46	0.54	10.78	0.25	3.91	-1.40	0.55	3.18	0.48	3.98	-2.87
1993	0.62	7.09	1.43	0.91	-44.33	0.37	4.35	-1.64	0.61	6.88	0.38	4.40	-1.26	0.62	13.14	0.24	4.63	-1.21	0.64	2.60	0.53	4.81	-4.84

GDP = Gross Domestic Product
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
NFA = Net Foreign Assets

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

EFFECTS OF A FIVE YEARS SUSTAINED INCREASE IN REAL GERMANY'S GOVERNMENT EXPENDITURES BY ONE PERCENT OF GNP

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	0.12	0.05	-0.48	0.03	1.39	0.76	0.32	1.08	0.11	-5.43	0.11	0.11	0.04	0.03	1.33	0.11	0.18	0.48	0.04	1.53	0.03	0.21	-0.22
1989	0.18	0.16	-0.46	0.05	1.51	0.74	0.92	0.89	0.18	-6.70	0.17	0.31	0.03	0.06	2.12	0.17	0.49	0.47	0.09	1.86	0.04	0.51	-0.48
1990	0.20	0.33	-0.39	0.08	1.38	0.48	1.63	0.83	0.23	-7.26	0.18	0.55	0.01	0.10	2.75	0.17	0.82	0.42	0.13	1.69	0.04	0.86	-0.81
1991	0.18	0.54	-0.29	0.10	0.92	0.19	2.27	0.63	0.27	-7.72	0.14	0.81	-0.01	0.12	3.19	0.13	1.12	0.33	0.16	1.44	0.03	1.17	-0.95
1992	0.14	0.78	-0.18	0.12	0.24	-0.04	2.76	0.41	0.29	-8.31	0.08	1.03	-0.05	0.14	3.50	0.10	1.35	0.22	0.19	1.35	0.03	1.42	-0.99
1993	0.08	1.01	-0.06	0.14	-0.68	-0.17	3.06	0.17	0.31	-9.10	0.03	1.18	-0.09	0.16	3.60	0.09	1.47	0.11	0.21	1.38	0.03	1.58	-0.97

GDP = Gross Domestic Product
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
NFA = Net Foreign Assets

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

EFFECTS OF A FIVE YEARS SUSTAINED INCREASE IN REAL JAPAN'S GOVERNMENT EXPENDITURES BY ONE PERCENT OF GNP

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	0.08	0.06	-0.18	0.02	1.69	0.12	0.15	-0.13	0.04	0.69	1.22	0.59	1.37	0.21	-5.01	0.05	0.18	-0.11	0.03	1.46	0.10	0.20	-0.46
1989	0.19	0.20	-0.13	0.06	2.31	0.20	0.43	-0.15	0.08	1.04	1.19	1.66	1.22	0.33	-8.09	0.12	0.50	-0.14	0.08	2.05	0.16	0.63	-0.53
1990	0.28	0.44	-0.06	0.11	2.43	0.25	0.80	-0.18	0.14	1.63	0.83	2.58	0.96	0.43	-10.41	0.17	0.89	-0.14	0.14	2.52	0.21	1.14	-0.56
1991	0.32	0.76	0.03	0.15	2.19	0.25	1.21	-0.22	0.19	2.31	0.44	3.88	0.64	0.50	-12.80	0.17	1.30	-0.17	0.19	2.68	0.26	1.64	-0.24
1992	0.32	1.16	0.13	0.20	1.83	0.21	1.61	-0.26	0.24	3.04	0.15	4.58	0.27	0.55	-15.23	0.15	1.67	-0.20	0.23	2.78	0.29	2.07	0.16
1993	0.26	1.59	0.23	0.25	1.13	0.15	1.94	-0.29	0.27	3.67	0	4.89	-0.09	0.57	-17.29	0.12	1.94	-0.23	0.27	2.60	0.32	2.39	0.45

GDP = Gross Domestic Product
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
NFA = Net Foreign Assets

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

EFFECTS OF A FIVE YEARS SUSTAINED INCREASE IN REAL LARGE INDUSTRIALIZED COUNTRIES' GOVERNMENT EXPENDITURES BY ONE PERCENT OF GNP

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	0.09	0.07	-0.31	0.03	2.11	0.13	0.25	0.40	0.05	1.40	0.13	0.20	-0.31	0.05	1.39	1.38	0.77	0.63	0.25	-6.79	0.03	0.38	-0.31
1989	0.26	0.25	-0.24	0.08	3.24	0.39	0.75	0.40	0.15	2.86	0.26	0.56	-0.28	0.11	2.90	1.34	1.99	0.44	0.40	-13.29	0.07	0.98	-0.49
1990	0.40	0.55	-0.10	0.14	3.98	0.57	1.42	0.35	0.26	4.40	0.32	1.02	-0.26	0.18	4.44	0.78	3.19	0.17	0.47	-19.25	0.10	1.67	-0.67
1991	0.47	0.97	0.05	0.20	4.05	0.61	2.18	0.25	0.36	5.93	0.32	1.50	-0.27	0.24	5.79	0.22	4.09	-0.11	0.51	-24.87	0.14	2.33	-0.42
1992	0.37	1.49	0.21	0.26	3.62	0.52	2.88	0.12	0.43	7.30	0.26	1.92	-0.27	0.29	6.88	-0.11	4.58	-0.37	0.53	-29.87	0.16	2.86	0.05
1993	0.21	2.04	0.36	0.32	2.42	0.36	3.39	-0.01	0.47	8.34	0.21	2.20	-0.27	0.32	7.54	-0.17	4.69	-0.59	0.55	-29.82	0.16	3.20	0.51

GDP = Gross Domestic Product
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
NFA = Net Foreign Assets

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

EFFECTS OF FOUR PERCENT SUSTAINED INCREASE IN THE U.S. MONEY SUPPLY TARGET

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	0.82	0.22	-4.48	-0.34	4.96	-0.41	-0.05	4.91	-0.08	2.38	-0.36	-0.07	4.57	-0.07	2.86	-0.31	-0.06	4.61	-0.07	-1.84	-0.12	-0.19	-3.32
1989	0.90	0.62	-4.11	-0.28	5.79	-0.26	-0.11	4.48	-0.06	3.48	-0.38	-0.17	4.18	-0.08	2.60	-0.36	-0.12	4.23	-0.08	-1.82	-0.05	-0.14	-6.48
1990	0.75	1.20	-3.86	-0.24	5.87	-0.05	-0.09	4.18	-0.03	3.72	-0.25	-0.23	3.94	-0.07	3.11	-0.29	-0.14	3.99	-0.07	-2.03	0	-0.01	-11.21
1991	0.56	1.90	-3.70	-0.18	5.38	0.06	0.03	3.96	0	3.88	-0.12	-0.19	3.79	-0.04	3.53	-0.19	-0.06	3.84	-0.04	-2.35	0.04	0.19	-15.77
1992	0.40	2.64	-3.61	-0.12	4.50	0.11	0.26	3.84	0.03	4.24	-0.02	-0.04	3.72	-0.01	4.29	-0.10	0.11	3.76	0	-2.60	0.06	0.47	-20.75
1993	0.26	3.36	-3.58	-0.05	3.24	0.08	0.55	3.78	0.07	4.66	0.03	0.20	3.70	0.02	5.02	-0.03	0.36	3.73	0.03	-2.95	0.08	0.79	-25.95

GDP = Gross Domestic Product
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
NFA = Net Foreign Assets

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

EFFECTS OF FOUR PERCENT SUSTAINED INCREASE IN THE GERMANY'S MONEY SUPPLY TARGET

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	-0.11	-0.02	0.82	-0.03	-1.50	1.68	0.47	-4.38	-0.15	0.41	-0.20	-0.05	-0.09	-0.01	-1.43	-0.18	-0.05	-0.34	-0.04	-0.69	0.04	0	0.79
1989	-0.07	-0.06	0.73	-0.02	-0.36	1.64	1.36	-4.19	-0.06	-0.59	-0.17	-0.13	-0.12	-0.02	-1.25	-0.20	-0.14	-0.25	-0.05	-0.66	0.07	0.16	2.15
1990	-0.03	-0.11	0.65	-0.02	-0.03	1.01	2.31	-4.10	-0.05	-0.20	-0.10	-0.22	-0.11	-0.03	-1.32	-0.20	-0.26	-0.15	-0.06	-1.50	0.07	0.28	3.25
1991	-0.01	-0.17	0.58	-0.03	0.10	0.38	3.06	-4.05	-0.05	0.75	-0.05	-0.30	-0.06	-0.04	-1.40	-0.15	-0.38	-0.08	-0.07	-1.84	0.05	0.35	4.08
1992	-0.01	-0.22	0.54	-0.03	0.08	-0.04	3.50	-4.03	-0.07	1.58	-0.03	-0.37	-0.01	-0.05	-1.54	-0.07	-0.48	-0.04	-0.07	-1.83	0.04	0.36	4.59
1993	-0.01	-0.29	0.52	-0.04	0.05	-0.23	3.63	-4.01	-0.08	2.03	-0.05	-0.42	0.03	-0.06	-1.72	0	-0.55	-0.03	-0.07	-1.51	0.03	0.32	4.95

GDP = Gross Domestic Product
GNP = Gross National Product
PGNP = GNP Price Deflator
MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
NFA = Net Foreign Assets

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

EFFECTS OF FOUR PERCENT SUSTAINED INCREASE IN THE JAPAN'S MONEY SUPPLY TARGET

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	-0.13	-0.03	1.04	-0.03	-0.71	-0.10	-0.05	-0.08	-0.02	-0.54	0.87	0.48	-4.43	-0.31	1.32	-0.01	-0.06	-0.10	-0.01	-0.79	0.17	0.13	0.61
1989	-0.15	-0.08	0.97	-0.04	-0.71	-0.10	-0.13	-0.09	-0.03	-0.45	1.00	1.30	-4.15	-0.19	2.68	-0.06	-0.17	-0.10	-0.03	-1.14	0	0.11	1.05
1990	-0.13	-0.17	0.93	-0.04	-0.68	-0.10	-0.22	-0.07	-0.04	-0.72	0.80	2.17	-4.09	-0.12	3.11	-0.10	-0.29	-0.06	-0.05	-1.51	-0.02	0.12	1.59
1991	-0.09	-0.27	0.92	-0.05	-0.48	-0.09	-0.32	-0.04	-0.05	-0.98	0.49	2.87	-4.18	-0.07	3.07	-0.10	-0.40	-0.01	-0.06	-1.56	-0.02	0.13	2.33
1992	-0.05	-0.38	0.92	-0.06	-0.20	-0.08	-0.40	-0.01	-0.06	-1.21	0.23	2.31	-4.33	-0.05	2.89	-0.08	-0.49	0.02	-0.07	-1.51	-0.01	0.13	3 26
1993	-0.02	-0.49	0.92	-0.06	0.19	-0.06	-0.47	0.01	-0.07	-1.38	0.07	3.48	-4.47	-0.05	2.84	-0.04	-0.55	0.05	-0.08	-1.31	0	0.11	4.29

GDP = Gross Domestic Product
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. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

EFFECTS OF FOUR PERCENT SUSTAINED INCREASE IN THE LARGE INDUSTRIALIZED COUNTRIES' MONEY SUPPLY TARGET

PERIODS	United States					Germany					Japan					Large Industrialized Countries					Developing Countries		
	GNP	PGNP	MERM	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GNP	PGNP	ER	RS	CURBL	GDP	PGNP	NFA
1988	-0.22	-0.05	1.85	-0.05	-2.16	-0.46	-0.13	-0.34	-0.10	-4.42	-0.05	-0.10	-0.14	-0.02	-1.32	1.01	0.48	-3.90	-0.27	2.90	0.07	0.21	1.57
1989	-0.25	-0.16	1.73	-0.07	-2.14	-0.51	-0.40	-0.22	-0.14	-4.09	-0.13	-0.27	-0.12	-0.06	-2.15	1.33	1.26	-3.73	-0.14	6.73	0.05	0.24	3.02
1990	-0.23	-0.32	1.67	-0.08	-2.04	-0.40	-0.73	-0.13	-0.16	-5.35	-0.17	-0.49	-0.05	-0.09	-2.86	1.08	2.06	-3.71	-0.08	7.68	0.03	0.22	4.12
1991	-0.16	-0.51	1.64	-0.09	-1.42	-0.22	-1.03	-0.08	-0.16	-5.68	-0.18	-0.70	0.03	-0.12	-3.31	0.62	2.65	-3.74	-0.08	7.95	0.02	0.17	5.03
1992	-0.09	-0.72	1.63	-0.11	-0.66	-0.03	-1.23	-0.05	-0.16	-5.55	-0.15	-0.88	0.11	-0.14	-3.59	0.20	2.94	-3.78	-0.10	7.89	0.01	0.11	5.94
1993	-0.03	-0.92	1.62	-0.12	0.22	0.08	-1.34	-0.05	-0.16	-6.73	-0.10	-1.02	0.16	-0.15	-3.74	-0.03	2.77	-3.80	-0.13	7.78	0.02	0.04	6.93

GDP = Gross Domestic Product
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MERM = MERM Weighted Effective Exchange Rate
RS = Short-Term Interest Rate
CURBL = Current Account Balance
NFA = Net Foreign Assets

. The numbers in GNP, PGNP, MERM and ER are percentage deviation from the baseline.
. RS is the change in the level.
. CURBL and ND are in billions of dollars.

PERTURBATION OF THE PARAMETERS OF THE MONEY DEMAND EQUATIONS
AND THE ELASTICITY RESPONSES OF EXCHANGE RATES

REFERENCE VARIABLE	PERTURBED COEFFICIENT	PERIOD 1	2	3	4	5	6	7	8	9	10
INTERCEPT	JA	1.56	1.72	1.60	1.54	1.48	1.41	1.33	1.23	1.14	1.05
	M0 LI	1.61	1.76	1.68	1.61	1.54	1.47	1.37	1.28	1.19	1.11
	US	0	0	0	0	0	0	0	0	0	0
ln(GNP)	JA	- 5.83	- 8.13	- 7.46	- 7.38	- 7.76	- 7.65	- 7.84	- 7.83	- 8.03	- 8.12
	M1 LI	6.15	- 9.28	- 7.93	- 7.93	- 8.08	- 7.96	- 8.11	- 7.94	- 8.06	- 8.07
	US	0	0	0	0	0	0	0	0	0	0
RS	JA	0.29	0.30	0.26	0.26	0.24	0.23	0.20	0.16	0.15	0.14
	M2 LI	0.30	0.31	0.27	0.27	0.26	0.24	0.21	0.17	0.16	0.15
	US	0	0	0	0	0	0	0	0	0	0
RS(-1)	JA	0.30	0.32	0.27	0.27	0.26	0.24	0.21	0.17	0.16	0.15
	M3 LI	0.32	0.33	0.29	0.29	0.27	0.25	0.22	0.18	0.17	0.16
	US	0	0	0	0	0	0	0	0	0	0
ln(M(-1)/P(-1))	JA	- 17.97	- 20.74	- 19.64	- 19.11	- 18.47	- 17.80	- 16.80	- 15.60	- 14.49	- 13.39
	M4 LI	- 18.63	- 21.33	- 20.5	- 19.88	- 19.14	- 18.41	- 17.31	- 16.19	- 15.07	- 13.99
	US	0	0	0	0	0	0	0	0	0	0

PERURBATION OF THE PARAMETERS OF THE MONEY DEMAND EQUATIONS
AND THE ELASTICITY RESPONSES OF CURRENT ACCOUNT BALANCES

REFERENCE VARIABLE	PERTURBED COEFFICIENT	PERIOD 1	2	3	4	5	6	7	8	9	10
INTERCEPT	JA	0.72	- 31.25	2.79	1.16	2.05	2.25	2.50	3.09	4.09	4.80
	M0 LI	2.34	32.21	2.42	- 7.68	- 15.03	- 13.66	- 38.14	2.11	3.03	3.22
	US	52.01	- 6.35	- 18.10	- 2.68	- 0.95	- 0.51	0.15	0.70	1.21	1.88
ln(GNP)	JA	- 3.30	- 70.52	- 17.94	- 4.75	- 8.74	9.68	10.90	- 13.70	- 18.18	- 21.89
	M1 LI	- 10.53	- 46.88	- 15.36	26.97	- 43.26	- 38.41	23.01	- 9.97	- 12.86	- 13.85
	US	63.22	23.69	48.59	10.18	3.57	2.03	0.54	- 2.78	- 4.94	- 7.75
RS	JA	0.13	- 4.89	0.47	0.21	0.37	0.40	0.42	0.50	0.70	0.81
	M2 LI	0.41	6.66	0.48	- 1.27	- 2.22	- 17.17	- 14.04	0.29	0.45	0.56
	US	11.73	- 1.25	- 2.87	- 0.44	- 0.15	- 0.09	0.02	0.10	0.22	0.36
RS(-1)	JA	0.14	- 5.20	0.51	0.21	0.39	0.43	0.45	0.53	0.74	0.85
	M3 LI	0.43	7.02	0.53	- 1.33	- 2.27	- 18.56	- 15.07	0.31	0.46	0.59
	US	12.32	- 1.30	- 3.03	- 0.46	- 0.16	- 0.09	0.02	0.11	0.23	0.38
ln(M(-1)/P(-1))	JA	- 14.15	122.69	- 19.54	- 18.04	- 31.16	- 32.89	- 34.93	- 41.31	- 50.09	- 53.11
	M4 LI	- 31.48	94.59	- 68.19	67.59	22.34	79.40	137.18	- 0.98	- 0.86	- 10.42
	US	268.66	59.36	95.33	26.24	8.71	3.89	3.33	- 9.59	- 15.98	- 23.82

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